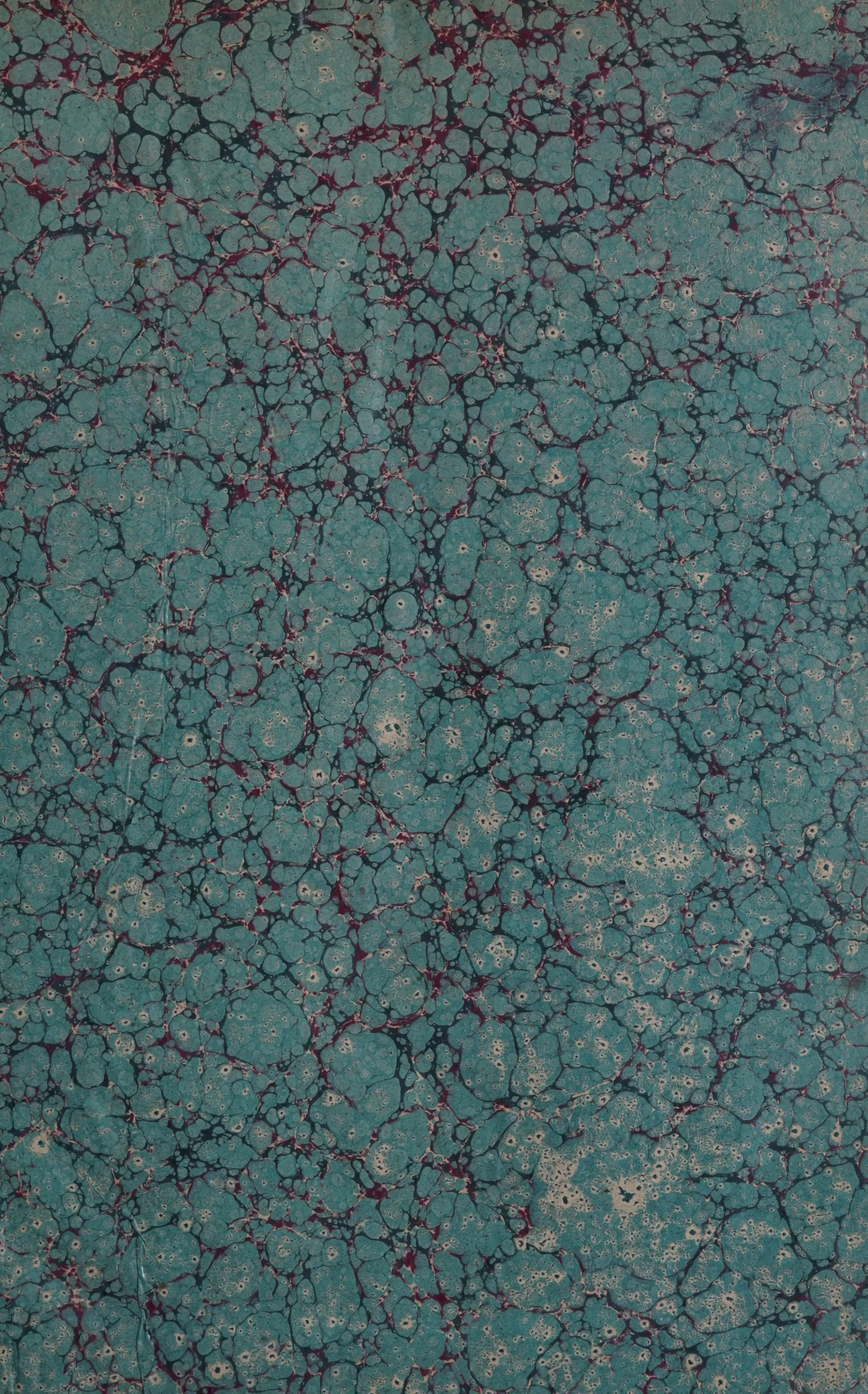




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## THE INTERNATIONAL OKONITE COM- PANY, LIMITED.

"CERTAINLY the person who is able to rate at their true worth the statements in prospectuses is very rare. We have no time to go to Vancouver's Island to learn whether the coal from there has the alleged percentage of carbon, and we should be no wiser if we went. We are not accountants; we must take for granted as true the assertion that the output or turnover was such-and-such, and the reserve fund is so-and-so. No one questions all this, so far as direct positive averments are concerned. . . . There is the cleverly drafted, skilfully baited prospectus; no one can lay a finger upon a phrase therein personally pledging anyone concerned in issuing it. . . . Anybody who cares to inspect contracts, more or less intelligible, . . . may find out the facts for himself. Everyone knows that there will be no such examination. Subscriptions will be made solely on the strength of the names of the directors or promoters. They are the bait, and they know it."

We quote the above from an article entitled "Limited Liability in Morals," in our political and critical contemporary, the *Speaker*. To those interested in the subject we can recommend the perusal of the entire article, which appeared in the issue of Saturday last.

On Monday was published the prospectus of the International Okonite Company, promoted by Woodhouse and Rawson United, Limited, one of whose directors (Samuel Pope, Esq., Q.C.) is on the board. The other directors are Lord Greville (chairman of Eastman's, Limited, a recent Stock Exchange success which it is of value to mention); Sir Alexander Armstrong; H. Dobree, Esq.; Major Charles Jones and Sir William Davies; Sir Rawson Rawson and Lord Aberdare being trustees.

At the head of the prospectus is a statement of the average dividends paid for the past 6 and 13 years respectively by, and the present market price of the shares of, the Silvertown Company and the Tele-

graph Construction and Maintenance Company. The capital is £340,000 in shares, and £100,000 in debentures, and the object is to purchase and extend the businesses of the Okonite Company, of New York, and Messrs. Shaw and Connolly, of Manchester. Okonite is described as "a valuable compound prepared and applied by special processes," and there is a statement of the manifold virtues which the Okonite Company claim for their products. The prospectus, as advertised, does not detail the reports of Sir Wm. Thomson and Dr. Hopkinson; but it states that it is "*mainly* on account of the high qualities of okonite wires and cables that they have consented to accept the responsible post of consulting engineers to the company." There are evidently other considerations, but they take quite a secondary place.

Then follows a description of the American factory, with particulars of its water-power and rental therefor; an accountant's report, which shows that the company has done a very satisfactory business for the past three years, with a remarkable increase in the last one. A momentary divergence takes us from accomplished facts into the region of "estimates," to which we need not now refer, as we have a larger instalment later. Mr. F. L. Rawson, having been sent out by the vendor company, reports that from "information he obtained," and persons he saw, he "became convinced that the business was of high class, the works and products excellent, and those connected with the company were men of probity and commercial standing"—a gratuitous testimonial which we hope they will appreciate.

The English business is acquired on the guarantee that the books, "when examined by the company's auditors shall give the results stated by" the proprietors to the directors, *i.e.*, over £4,000 last year, and for this year at the rate of £6,000 per annum. Considering the detail with which the American profits are set forth, and the certificate thereon, there is something wanting in the statement relating to the English business. "The company's auditors" took steamer for New York,

or the New York books were sent to London. Why couldn't they take the train to Manchester, or the Manchester books be sent to them? What is the nature of the "guarantee?"

There are the usual baits of probable subsidiary companies, and powers to pay interim dividends.

After particulars of management, its complicated remuneration, and a statement that the present holders of the business have agreed to retain £100,000 worth of shares for four (with such prospects the wonder is they do not make it forty) years, there is given in considerable detail an estimate of future profits, which "is based on the information supplied by the Okonite Company of America, and Messrs. Shaw and Connolly, to the directors." Estimates are given separately for the present and three following years, according to which the debentures are always to get their 6 per cent., the preference shares their 8 per cent., and the ordinary shares their 15 per cent., with occasional bonuses in addition for everybody but the poor debenture holders, leaving surpluses of a very improving character, which are conveniently summarised, and go towards an extra bonus. We think this extra bonus sufficiently shadowy to render it unnecessary for us to set it forth in detail. The purchase price has been fixed at £224,990—£113,330 in shares, £33,300 in debenture, and £78,360 in cash. The average profits of the American business for the three years is £14,000 per annum. There is no material for an average of the English business, but taking the figures "guaranteed" for last year's profits (£4,000), we have £18,000 per annum for the profits of the combined businesses. The company purchases these at the rate of  $4\frac{1}{3}$  years' purchase in *cash*,  $1\frac{5}{8}$  years' purchase in *debentures*, and nearly  $6\frac{1}{3}$  years' purchase in *shares*; altogether about  $12\frac{1}{2}$  years' purchase. Or, if we do not take an average, the purchase price is at the rate of eight years' purchase on the business of 1889.

It seems to us the directors might have omitted some of the matter in the prospectus in order to find room for expert testimony that  $12\frac{1}{2}$  years' purchase on the average of three years' business, or eight years' purchase on one exceptional year's business, is a fair and reasonable rate; or they might have profitably stated that if they were buying the businesses in their private capacity they would have jumped at the opportunity.

We do not overlook the fact that the purchase includes such tangible assets as buildings and machinery, as well as such intangible ones as processes and goodwill. We should have preferred to separate the wheat from the chaff, but the prospectus does not give us an opportunity of doing so. We have not deducted anything on account of patents, though the new company purposes providing £1,000 a year for depreciation. No details are given regarding these patents, so that we cannot form any idea whether the American Company is right in deducting nothing, or the English Company making unnecessary sacrifices in deducting too much.

Under the circumstances, it may be matter for regret that over £110,000 is left for "working" capital.

The accountants "examine and report," the experts "report," Mr. Rawson "becomes convinced," the Okonite Company "claim," Messrs. Shaw and Connolly "guarantee," and "estimates are based on information." With all this, however, are the directors free from responsibility? We think not. What is the general effect produced on the average investor unfamiliar with electrical enterprises by a perusal of the prospectus? Being told that the India-rubber Company has paid an average of 13 per cent. during the last six years, is he expected to enquire whether it has always paid that munificent dividend? When it is stated that the Telegraph Construction and Maintenance Company has paid 20 per cent. per annum for a number of years, is he to assume that the Okonite Company starts with the same valuable connection? Do the directors wish him to understand that the Okonite Company either can or will be engaged in a similar business to either of these companies? When an estimate of future profits is given in such detail as to occupy, more or less, 100 lines in the *Times* newspaper, and contains the important "Note" that "the calculations of dollars into pounds are made at \$4.85 to the £ sterling," is the intelligent Briton expected to arrive at the conclusion that the estimate is purely imaginary and absolutely valueless, or is he expected to be impressed with "15 per cent.?"

The promoters and directors cannot shift the responsibility for the publication of such an estimate and the inference to be drawn from it. Mr. Samuel Pope, Q.C., in his capacity of Chairman of the English Association of American Bond and Shareholders, has surely had some experience of disappointed hopes in limited companies. Sir Alexander Armstrong has been connected with some electrical concerns. He might perhaps give his colleagues some information bearing on the question of estimates and results—the relation of prospectus to performance. The directors, as a body, must be aware that businesses have their ups and downs. The Okonite Company has had its ups—very good ones. Is it absolutely impossible that there should be an alteration in the direction of the curve? Is it possible that the sale to, and management by, an English company may in any degree affect the continued successful working of the American business?

We are not concerned with the quality of the material itself. The development of the American company would imply that either it must have some considerable merit or the business have been well managed—perhaps both.

Placed upon the market in a business-like manner, we would have heartily welcomed Okonite. As it is, we can but condole with it in its misfortunes. To be expected to pay a dividend on a capital of £440,000, with an expensive organisation and ornamental directors, would appal many better substances than Okonite. We hope it may be equal to the occasion, and that our fears of disaster for the company may be mistaken.

We think that the shareholders of Woodhouse and Rawson should recognise the value of the permanent

staff in carrying on what is generally understood to be its "legitimate" business, for we do not see how the directors and managers can well spare for details any of the time which must needs be occupied in the promotion of companies from copper-deposition to co-operative stores. With the interest of the electrical trades at heart, we would suggest to them the selection of one or other *rôle*—electrical supplies or company promotion. We fear they will find that the combination is not consistent with sound business on a permanent basis. If they should decide to give up the company promotion department, we should not regret it. We have no desire that electrical affairs should be placed before the public in a form which is at least misleading, and which must almost inevitably produce disappointment to the investor and detriment to the electrical profession.

A correspondent sends us the following :—

"Full information is given in the prospectus as to the business of the two concerns, and the opinion of an expert is quoted as to the desirability of acquiring the American business with the view to its extension by means of a company. The expert who went over to the States to examine into the value of the manufacture of *okonite* and the business of the concern is, I learn from the prospectus, the managing director of the company who are now promoting the new undertaking.

"The profits of both undertakings are given during the past few years, and the estimates of the future profits are given on a considerably-increased scale, and the dividends to be derived are fairly compatible with the case if *no other wire* but *okonite* was ever used. There is one point in the estimates of the future profits I should like to draw attention to, as it has an important bearing upon the actual amount which should be realised. In the prospectus it states, 'there is every reason to believe that in the near future, when *okonite* covered wire can be obtained in England for home consumption and export to other countries, the profits from the English branch will equal, if not exceed, those of the American.' *Okonite* wire has been before us in this country, and of late has been pushed forward by a well-known firm, and, I believe, its use has been extended; for all this portion of the business and its increase the American factory turns out the wire, and the present and future profits are credited to the American factory, not only now, but in the future. The *okonite* wire will soon, according to the prospectus, be manufactured here, and the business is expected to be large; the English profits are therefore increased by the home consumption of home-manufactured wire, instead of obtaining it from the States; but no alteration has been made in the prospective profits, on account of the American branch losing all the British, and, probably, European trade. In fact, the American branch is calculated to yield an increasing profit on business now shipped here, which will, according to their own showing, be taken away from them by the English factory.

"It may not be valueless to point out that the com-

pany is formed to acquire the business of the *Okonite* Company, and to extend this special insulation. The patents in connection with this wire are for various modes of manufacture, and the material called '*okonite*' is a compound in which rubber plays the most important part; the combination is a secret, and is therefore valueless from a monetary point of view."

## OVERHEAD TELEGRAPH WIRES.

THE small majority of three, by which the London Overhead Wires Bill was recently rejected, seems to show that opinions on the subject are pretty equally divided, and that it was a mere chance that turned the balance against the measure. The Bill conferred upon officials of the London County Council powers of compulsorily entering upon private property at any time for the purpose of putting up wires and inspecting them; and, with the usual exaggeration, many of the speakers drew pictures of the terrible and outrageous infringements of private rights which would ensue if freedom of access were given to workmen to the roofs of houses to place new poles or repair wires. One member stated that since he had given a telephone company permission to put a wire over his house, it "had never been his own. The inspectors were always in and out, his stair carpets were worn, and his silver had to be constantly locked up for fear it should be stolen. The poles, moreover, were fixed so badly, that considerable damage was done to the roof of his house. The company declined to repair the damage, and it cost him £50 to put the roof in order when he applied for the removal of the poles. To that inconvenience every person would be subjected who had wires fixed to his house, and he protested against its being done whether an owner or occupier objected to it or not. The question was not one of erecting telephone wires, but of electric lighting wires, with the erection of which they were threatened all over London, and which was a very much more serious matter. They were in the infancy of the system, and yet they had already realised that those wires greatly increased the risk of fire, a proof of which was that the insurance offices had raised the rates for that property to which electric lighting wires were fixed."

We cannot but believe that the hon. member's statement is an exceedingly highly coloured one, though it may have some foundation in fact; but even granting that it is correct in the main, there ought to be no difficulty whatever in so amending the Bill that such inconveniences as those described should be reduced to a minimum. It was also stated that workmen claim the right of access at all hours to a roof where a telephone pole is fixed; and, further, that the Bill would empower the Council's officers by day or night to enter into private houses. With reference to this, it was pointed out that one of the great dangers of the overhead wires was that there were in London a great number of derelict wires, and therefore it was most necessary that workmen should be appointed by

the local authorities to deal with the wires. Clause 8 of the Bill provided that the inspector of the Council might enter a private house provided he were in uniform, and duly authorised in writing by the local authority, and provided that notice had been previously given. The inspector might then enter at some reasonable time to be named by the occupier. The rights of householders are thus most stringently guarded.

The great objection to the Bill was that power was given to put up a pole against the will of the owner of a house; but, as Mr. Courtney pointed out, the clause empowering this to be done could be struck out, but it was entirely a different thing to oppose a Bill which was admittedly a useful measure; this reasonable argument, however, did not appear to have much weight, and, for the present, things are to remain as they are.

#### Primary Batteries.

SOME of our contemporaries have commented upon M. Weymersch's primary battery without apparently perusing the report upon which their remarks are ostensibly based. One compares the cost of producing electricity from galvanic elements with that of central stations, and the result is naturally against the battery; furthermore, for the manipulation of the apparatus, it is contended that a new form of domestic servant must be forthcoming, although in reality the duties attached to filling and emptying the cells are but little more onerous than those entailed in a bath room. To say that the everyday attention required for a battery of this type is quite beyond the resources of small houses is altogether erroneous, and simply shows that the writer is not acquainted with the means adopted to reduce the labour and time employed on the battery to a minimum. In another important exchange it is stated that "though only intended for use where steam power is not available, the Weymersch battery gives results almost comparable with steam engine and dynamo." How this conclusion was formed we know not; certainly the report does not lead to such a belief; but perhaps the plant with which our contemporary is best acquainted is expensive to maintain. At all events the report seems to have been passed through a "Hedgehog transformer;" in no other manner can we account for the impression which was produced in the writer's mind.

#### The Rival Systems.

THE comparison of the battery *v.* the steam engine and dynamo, brings up another question, one which we discussed at considerable length in our leading columns for June 20th. From figures which have been sent to us, it appears that an average of 17 to 18 lbs. of good coal is used in alternating current stations per net unit sold; whereas the amount necessary in supplying the continuous current on the three wire system, with or without accumulators, is just about half, viz., from 8 to 9 lbs. Furthermore, we are assured that the total cost of engine room expenses, which includes fuel, water, petty stores and wages, was, in the case of a West End company, averaged throughout last year, a trifle under twopence per unit for the continuous current supply. The figures for another station, working alternating machines and transformers, averaged for the best three months of the year, showed the cost per unit to be

over sevenpence; and in another instance, that of a provincial station, over ninepence. Summing up, the data placed in our hands leads to the conclusion that at the present moment the companies working continuous currents, with or without accumulators, are producing electrical energy in the engine room at less than twopence per unit, whereas in the case of alternating current stations, the average appears to be over sevenpence. It seems almost impossible that there can be such a difference between the cost of production in the respective systems, but our informant stands so high in the profession and has had such great experience in central station working, that we hesitate to think he has made a mistake; the matter, however, is one demanding serious consideration, and we shall be glad to learn that the cost given for alternating working is open to modification, for unless we know all the circumstances and conditions of supply, the steam engines employed, the kind of drive, and, above all, whether the station considered as a whole, or the factors of which it is composed are working up to their full capacity or only partially loaded, the figures can scarcely be accepted *in toto* as fairly representing the merits of the two systems. Perhaps the London Electric Supply Corporation will favour us with an analysis of its working expenses!

#### The French Submarine Cables.

THE Direction General of the French Posts and Telegraphs is much occupied at the present moment with the establishment and repair of telegraph cables. In concert with the Post Office, the Administration is considering the laying of a new cable between London and Paris. M. Selves has also submitted for the approval of the Minister of Commerce a report on the defective condition of telegraphic communication between Tunis and Algeria. The attention of the Director-General has been called to this state of affairs by the Governor of Algeria and the French Resident General in Tunis. In reality, the State only possesses three Franco-Algerian cables. One of these was laid in 1871 and works in very bad condition, the other not being much better. The third alone works well, but is not sufficient to ensure the service. The sole solution consists in the laying of two new cables uniting Marseilles to Tunis and Oran. It is in this sense that M. Selves has drawn up his report and asks the Minister to get the Chambers to vote the credits necessary for the immediate laying of these cables. M. Selves has also asked M. Jules Roche to obtain other credits with a view to improving telegraphic communications with Corsica, the defectiveness of which was so much remarked upon during the tour of the President of the Republic.

#### Smoke Abatement.

THE "smoke annihilator" invented by Mr. Samuel Elliott, of Newbury, and to which we called attention in our last issue, may do all that is claimed for it, but no data is to hand as to the cost of and power demanded in working the apparatus, or its reliability; neither have we seen a report upon it by anybody claiming to be an authority in mechanical engineering matters. It is an easy thing to get together a heterogeneous assemblage of individuals who, without being at all acquainted with the process they are invited to view or of its mechanical details, are always ready to pronounce the apparatus capable of effecting a revolution in any industry to which the

inventor intends it to be applied. Until some details of its performance outside the inventor's premises are available it would be unwise to express any definite opinion on the subject; at the same time we hope that Mr. Elliott's sanguine anticipations will be realised.

#### The Electric Lighting Acts.

A WELL-KNOWN electrical corporation has registered several local companies with nominal capital for the purpose of obtaining provisional orders under the Electric Lighting Acts. Lest any misapprehension should exist as to the policy of this move, we may mention that it is rendered necessary by the attitude which has been taken up by the Board of Trade in practically declining to allow a provisional order to be assigned. In the places where the corporation has applied for provisional orders it has definite and valuable interests to protect, and if it had not so applied in these places it would incur the risk of losing its rights there. It must be obvious that it is not practicable for a manufacturing and contracting company to permanently work provisional orders in a large number of provincial towns, and as the Act also provides that the undertakers shall in the case of each provisional order keep separate accounts of the undertaking, it is advisable for these reasons alone to register in each place, where there are interests to protect, a local company with a nominal capital, to be increased as circumstances require.

#### Experts' Opinions.

IT is admitted that the Blackpool Electric Tramway has been a commercial success, but this has been attributed by experts in some quarters to the fact that the town is a summer pleasure resort, and that therefore the same happy financial state would obtain with horsed cars. Probably the majority of tramway men consider that the best paying lines are those having a regular traffic, so it is easy to show that the opinions to which we refer are mistaken ones. At Blackpool during winter not more than four cars are run, the mileage being only 45 per car day, whereas in summer eight to ten cars are employed, each with a daily run of 52 miles. To meet these conditions with horses would necessitate buying them when dear and disposing of the bulk of them when cheap, or keeping them in idleness and eating their heads off during the cold weather. How great the actual difference really is can best be shown by an incident which occurred during the summer of 1877. A breakdown occurred in the insulation of the line and horses were hired from one of the large tramway companies in a Lancashire town. During the month when horses were employed, the average cost per week was £113, but during similar periods of time previous to the hitch and since, the electrical working cost has not exceeded £45. It may be urged that using one's own animals would cost less than when depending upon the hire system; still the enormous difference between the figures above quoted must conclusively refute the statement that Blackpool would be as commercially successful if worked by horses.

#### Accumulator Traction.

A WELL-KNOWN engineer points out that though accumulators have been in the hands of capable engineers, backed with almost unlimited capital, still no system of working tramcars by these storage cells exists that can

be shown to pay. To contract at a price is one thing; to make the business pay, except by disposing of it to someone else, is another. The Elieson Company, says our authority, found its 4½d. per car mile contract cost nearly three times that sum, and the Brussels company, after a lengthened period of apparently successful running abandoned the method, because, as the chairman was reported to have said, "the system failed commercially on every point." Can any user of storage batteries show a set of cells which have been in daily use for tramcar work for 12 months and that are still in good condition?

#### The Cost of Electric Haulage.

WHILE upon the question of the cost of various electrical tramways, would it not be well if some systematic and generally accepted scale could be determined upon so as to show definitely what items should or should not be included under cost of haulage. There are not so many conflicting interests in this country at the present moment but that this problem could be readily solved.

#### Business Men Interviewed.

A REPRESENTATIVE of the *City Leader* has interviewed Mr. Joseph Smith, the managing director of the Electric Construction Corporation. The interview lasted but 10 minutes, but in that brief period a number of stupid questions were answered in such a manner that it is no wonder electric traction hangs fire in this country. What a lucky thing for the readers of the *City Leader* that Mr. Joseph Smith limits his conversational powers to just the sixth part of an hour.

#### The Tramways Institute.

THE Tramways Institute of Great Britain and Ireland held its annual meeting on Wednesday, at the Westminster Palace Hotel. The proceedings were remarkably dull until the reading of two papers on electric traction, when a lively discussion took place regarding the Barking line. We hope to deal with this subject in our next issue, especially as one gentleman advanced figures to show that the line was a failure from a commercial point of view. Yesterday (Thursday) some of the members visited the Barking Electric Tramway.

#### Seeing by Electricity.

WE are pleased to notice that the *Standard*, in describing the Celebration Jubilee of the Penny Post, alludes to the labours of the late Robert Sabine in the direction of "seeing by electricity." His experiments with selenium are probably now known to but few, and it is not difficult to identify the *Standard's* representative.

#### Burnand's New Burlesque.

MR. F. C. BURNAND has written to the *Times*. He has a grievance against the K. and K.E.L. Company, because its employes dig up the streets and pathways for the purpose of laying mains. We consider that the gentleman has little cause for complaint, and the company might give him a *quid pro quo* for allowing such feeble matter as sometimes disfigures the pages of *Punch* to appear under the guise of wit and humour.

FRENCH NOTIONS ON ACCUMULATOR  
TRACTION.

PERSONS who are either directly or indirectly interested in the development of electric traction, especially on the accumulator system, which appears to be, as yet, the best system applicable for urban and suburban traffic, are always seeking for data regarding, not only the initial cost of installation, but also as concerns the cost of renewing the plates of the accumulators, the amount of money for the depreciation of the motors, gearing, &c., the actual working expenses at the charging station, and the depreciation of the plant therein installed. No trustworthy details, with the exception of the first item, can be obtained in this country concerning these expenses, and time alone will bring forth the results. Everything, at present, is based upon estimates which are of no earthly use; absolute facts only are required. In this connection it is interesting to note that the estimate mania has arisen in France.

In the course of a few weeks there will be published in Paris a work which has been prepared by M. Paul Gadot, of accumulator fame. This gentleman's book establishes, or pretends to establish, a parallel between animal traction and electric traction by means of accumulators on tramways. The question in the two cases is the working of a tramway similar to those in Paris, the cars, cost of working, traffic, &c., being taken into consideration. The author presents three projects to solve the problem of electric accumulator traction. The first refers to that in which the accumulators are carried in the car itself; the second where batteries are independent of the car and are carried in a special car or waggon; and the third to cells arranged in a special waggon which also carries the driver, this being termed the electric locomotive.

M. Gadot extols the second system, which, according to his opinions, ensures the independence of the cars and accumulators, diminishes the working expenses, since the batteries are no longer put into place, or removed by hand one after another, in order to be recharged; and the cars do not have to be taken back to the dépôt to receive a set of freshly charged cells as they stop at the terminus where special cars containing newly charged cells are kept in reserve.

The *Bulletin International de l'Electricité* thinks that such a system would be objectionable, owing to the increased length of the car, and to the consequent interruption in traffic. Our contemporary might have added that such a system would necessarily augment the dead weight to be hauled.

From a financial point of view M. Gadot considers all possible combinations, and concludes in favour of electric traction, as follows: "We will suppose that the traffic is carried on by cars of the General Omnibus Company's type, each carrying 50 passengers and weighing 3 tons 7 cwt. when empty, and 3 tons 13 cwt. being the weight of batteries, motors, gearing, &c., making a total of 7 tons. Each car would travel daily 62 miles, and the average power developed is about 23 lbs. per ton. (?) The number of cars should meet the requirements of the omnibus company.

"In the first system suggested, by changing the cells three times a day, they are not quite exhausted, and the cost per car-kilometre comes out at  $4\frac{1}{2}$ d., or  $7\frac{1}{2}$ d. per car mile. In the second system the special car containing the batteries is changed three times daily, and the cost per car-kilometre is also  $4\frac{1}{2}$ d., or  $7\frac{1}{2}$ d. per car mile. In the third system the cost per car-kilometre is higher than in the two previous cases. Turning to the cost incurred by the Compagnie Générale des Omnibus de Paris for horse traction per car-kilometre, M. Gadot states that it amounts to  $5\frac{1}{2}$ d., or 9d. per car mile. This, then, is more than one penny per car mile in excess of the estimated cost of electric traction. Now, contends the author, from the fact of the reduction in the *personnel* of the company by the adoption of electric traction, by the letting out on hire or the sale of the

premises which would not be required, such as stables, granaries, &c., the Compagnie Générale des Omnibus would be able to reduce its capital by nearly £310,000!"

M. Gadot appears to neglect the most simple system of carrying the accumulators under the car seats, and the motor and gearing under the body of the car, for the complicated and certainly more expensive system, both as regards initial expenditure and maintenance, of employing a second car to carry the accumulators. This has been so demonstrated by the Stratford *fiasco*, although the system there employed was slightly different to the author's favourite, but it corresponded to the third method suggested by M. Gadot. Then, again, the cost of maintenance and depreciation of plant appear to be left out of the question. Taking the estimated cost of renewals alone at from 1d. to  $1\frac{1}{2}$ d. per car mile, or a mean of  $1\frac{1}{4}$ d., the cost of accumulator traction in Paris would exceed that now incurred for horse haulage, and the estimated reduction of the capital of the Compagnie Générale des Omnibus by nearly £310,000 entirely vanishes, although a saving in stabling, &c., would be effected. M. Gadot also leaves out of consideration the drivers' wages, &c., both as regards horse and electric traction. If he could furnish reliable data concerning the four accumulator cars which have been running for some time on the Madeleine-Levallois line of the Compagnie des Tramways du Nord, in Paris, M. Gadot would render great service to the electrical profession, who do not require, and will not accept, bare estimates on electric traction. In the meantime, we do not see the utility of a treatise containing estimates and devoid of facts.

THE GAS COMPANY AND THE ELECTRIC  
LIGHT AT BUDAPEST.

[FROM A CORRESPONDENT.]

THE question of the electric light at Budapest seems on the point of developing into a genuine sea-serpent, and if, after my repeated reports on the different phases of this affair, I refer to it again, it is merely because I consider it instructive for the widest circles, and consequently also for your readers, in so far as many municipalities which are in the same position as Budapest as far as lighting is concerned may learn from the proceedings there what a city ought *not* to do if it wishes to defend its own interests.

In my former reports I have already explained in what a peculiar position the city of Budapest is with regard to the existing gas agreement, as the gas company, up to 1891 inclusive, has the exclusive right of utilising municipal territory (streets, lanes and squares) for any lighting purposes whatever. Now, instead of looking out betimes that the city after the expiry of this monopoly should at once enter into the actual enjoyment of the recovery of its freedom of action, the city has for some years allowed itself to be led astray by the gas company, which, according to circumstances, boasting partly of alleged agreement rights and partly professing a benevolent readiness on its part, has with refined craft hitherto succeeded in keeping back the city from a definite decision on the lighting question, and in this manner to postpone the grant of a concession for the erection of electric works at Budapest. After the gas company first emphasised its—merely alleged—right by agreement, according to which negotiations with other lighting companies could be undertaken only after negotiations with the gas company, and after it had attained its purpose of protracting such negotiations as long as possible, it declares itself willing to take the electric lighting in hand (naturally!) and to enter into negotiations to that end with the municipality. As a matter of course, during these discussions the negotiations already entered into with other parties were broken off, and the gas company could again say to itself, "Time won, every-

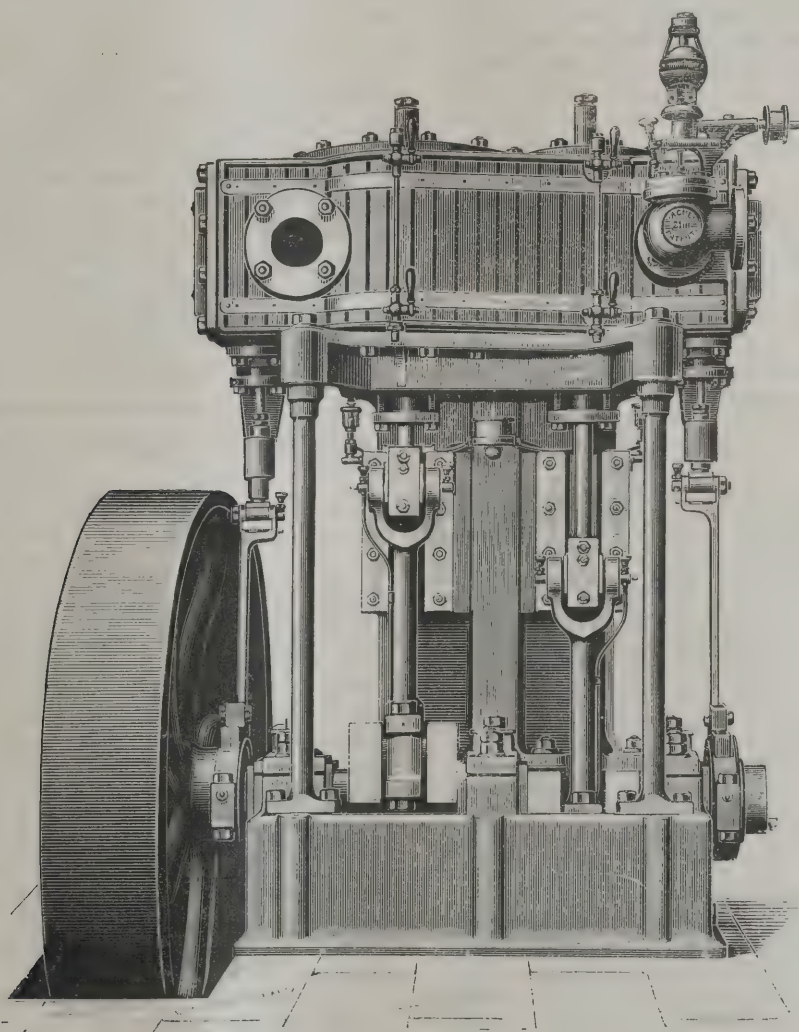
thing won." When, then, the gas company, after a considerable time, thought it prudent again to move in the matter; it declared that it would magnanimously give up its monopoly (which has only two years to run) and make a few other concessions if the city would prolong their gas agreement for 15 years more. At the same time the gas company demanded that the question of electric lighting should be decided in the way of a *public competition*. The invitation to this competition, of course, could only be given after the formal conclusion of the negotiations with the gas company, which, it was to be foreseen, would be very tedious, and the company well knew how long electrical works have to be waited for if they are to come into execution as the results of such a competition.

The City of Budapest in the meantime, which fancied itself at last at the goal of its wishes, accepted in principle the proposals of the gas company, and merely demanded the acceptance of a few further conditions which have been already communicated in your paper.

in preventing for an indefinite time the erection of electrical works at Budapest, and, without doubt, it has reached this object by an expenditure of cleverness which must be admitted. Whether this skilful management has been really prudent is another question. We see that many other gas companies, *e.g.*, the Società Anglo-Romana at Rome, and the Innsbruck Gas Works have secured and promoted their interests in an effective manner by erecting electric works, and uniting the two kinds of illumination in their own hands.

#### THE "CENTRAL STATION" VERTICAL SIDE-BY-SIDE COMPOUND HIGH-SPEED ENGINES.

THE annexed wood-cut represents a type of vertical compound engine, made by Messrs. Browett, Lindley and Co., which has become deservedly popular for



A few days ago the reply of the gas company was received, which in the most important points is in the negative! Now the negotiations may begin again, for the city thought that it merely needed to ratify the application for a concession which had been made years ago from another quarter, and had been already discussed by the municipal commission of lighting, and accepted in principle, in order in a short time to come into the possession of electrical works.

Meantime the Mayor of Budapest set off to Paris in order to study there electric lighting, with a view to utilising at home any observations which he might make. This is simply carrying coals to Newcastle, if we remember that the most important towns and lighting installations of the Continent have repeatedly sent representatives to Budapest, in order to study electric lighting there.

The gas company has, therefore, once more succeeded

electric lighting on account of the small floor space occupied for any given power, as well as for the simplicity of its construction, the steadiness of its working, and the high speed at which it can be run, thus dispensing with countershaft and large flywheel. In addition to these advantages all parts are easily accessible and removable for necessary examination and repair when worn.

The crank shafts are of mild steel, forged in one piece, most accurately finished in all parts, and well supported in three main bearings, of large proportions. The cylinders are cast of hard, close grained iron, and securely bolted to the vertical frame. The pistons are constructed on the most approved method, and fitted with broad cast iron rings, expanded by steel spiral coils.

One of the most important improvements in detail is the construction of the piston rod and cross-head, which

are forged in one piece of steel. This consists in cutting out the cross-head, so as to receive the brasses from the front, instead of from the bottom, and tying the jaws together by a solid steel cap, lipped over at each end, and bolted to the face of the cross-head by two turned steel bolts passing right through it, and serving also to secure thereto the broad cast iron slipper which rides on the slide face, the whole being screwed up tight, metal to metal, and the nut secured so as not to shake loose. The strain of working is thus not borne by the bolts, and these require no adjustment, the brasses in the cross-head eye being set up by separate screws actuating a broad wedge, and providing an ample metal to metal surface at this most important joint. The joint was invented by the makers, and has been used in all their electric light engines for years.

The well-known "Acme" patent governor is used on these engines, ensuring the greatest regularity under all variations of load, but automatic expansion can be provided when required, by using an improved drum governor on the shaft controlling the cut-off direct. For the higher pressures of steam, now in vogue (120lbs. and over), piston valves are provided on the high-pressure cylinders to reduce the wear and loss in friction.

### BELT STRENGTH.

By ROBERT GRIMSAW, PH.D.

THE problem often presents itself how to figure out in a moment whether or not a certain belt is strong enough to carry a certain horse-power at a certain speed. It is always well not to strain a belt, and sometimes there is not only danger of ruining the belt but a chance that breakage may work damage to business or property.

We will suppose that the belt is a leather one, running upon a cast-iron pulley. We know that the pull it exerts on the pulley is equal to the strain upon its tight "side," or fold, less that upon the slack side, or fold, and that this pull in pounds, multiplied by the belt speed in feet per minute, and divided by 33,000, will give the horse-power. (This is assumed as correct. It is true, and there is no time to prove it now.)

Of course leather varies in strength; and no matter how strong the belt is, if the lacings or other fastenings are weak, the belt will be in danger. The greatest strain upon the belt, in pounds, is equal to the breadth of the belt in inches, times the thickness of the belt in inches, and times the safe working strain per square inch of cross section of the belt; this latter depends upon the kind of leather and upon its fastenings.

As to these fastenings, it is safe to assume, as the result of experiments made, that for ordinary single leather lacings the average breaking strength is 950 pounds per square inch; single rawhide, 1,000; double leather, 1,200; double rawhide, 1,400; and riveted joints, 1,750.

Of course the safe working stress in pounds per square inch will be less than this; and we may put them about as follows: single leather lacing, 325 pounds; single rawhide, 350; double leather, 375; double rawhide, 400; and rivets, 575.

Working from this we find the square inches cross section of the belt to be for belts which are single leather laced 1-325, the greatest tension; where they are laced with single rawhide, 1-350; with double leather, 1-375; with double rawhide, 1-400; and where they have riveted joints, 1-575.

Thus, if we know that we are going to use a single leather-laced belt  $\frac{1}{4}$ th inch thick, and that it will have a force of 500 pounds on the pulley, and that the arc of contact will be 105 degrees, we know that the greatest strain on the belt will be  $500 \times 1.93 = 965$  pounds; and dividing this by 325 gives practically three square inches of cross section needed. As the belt is to be  $\frac{1}{4}$ th inch thick, it would need to be  $3 \div \frac{1}{4} = 12$  inches

wide. If it were  $\frac{1}{8}$  inch thick it would need to be only  $3 \div \frac{1}{8} = 12$  inches wide; and if  $\frac{1}{2}$  inch thick, only  $3 \div \frac{1}{2} = 9$  inches wide. For every arc of contact there is required a different multiplier; these are got from tables which have been calculated by correct theory and proved by accurate experiment. Thus, for 30 degrees arc of contact the amount of pull upon the pulley is 0.189 times the greatest strain on the belt; for 60 degrees it is 0.2967 times; and so on, according to the following table:—

Arc of Contact.	Multiplier.
30°	0.1890
45	.2695
60	.2967
75	.4082
90	.4673
105	.5181
120	.5650
135	.6098
150	.6494
165	.6803
180	.7143
195	.7409
210	.7692
240	.8130
270	.8475
300	.8772

This table (from the *Electrical World*, which is here published for the first time) is very convenient for ready reference when it is desired to know how much actual drive can be had out of a belt having a given breaking strength. Thus if we have a leather belt the safe-breaking strength of which is 1,000 pounds, we may know that all the pull that it can be made to put upon a cast-iron pulley, with 90° arc of contact, will be  $1,000 \times .4673 = 467.3$  pounds; but if the arc is 180° we will be able to get 714.3 pounds pull with the same maximum strain upon the belt.

### THE MANAGEMENT OF ACCUMULATORS.\*

By J. K. PUMPELLY.

#### IV.

IT was discovered by Planté, and by the experience of others since, that many more hours of discharging are needed to convert the positive plates into a peroxide of lead than to change the negative plate into finely divided lead, which is evidently the process necessary, as far as practical results go, to make the battery efficient to its full capacity. To do this, one or two charges and discharges are necessary, so that in reality we cannot expect to obtain our estimated percentage of efficiency until this forming work has been done, by the current of electricity put into the battery and taken out of it. Let us suppose now that this has been done three times consecutively, then we make our test trial. We have the 30 batteries and a series of 10 60-volt lamps connected, and we find that these 10 lamps are burning well up to candle power for seven hours; that is, 70 ampère hours have been consumed, and the voltage of the battery stands at 58 volts. Hence the lamps will burn two hours and a-half more, making 95 ampère hours of useful work, but not with as high candle power. Now we find it best to take off the lamps, leaving about 20 per cent of the charge still in the battery. This method is preferred, as it seems to prevent the action of the sulphuric acid directly on the lead plates, and also shortens the time of the next charge. Now we charge again with a current of 20 amperes, and find that after five hours' run in discharging on 20 lamps we have about the same efficiency as before. Again we increase the charging current to 20 amperes, and the discharge to 30 lamps, and find a slight loss in our heretofore fair percentage. Hence we conclude by experience that a 25-ampère charging current is sufficient for a 100-ampère hour battery, and the discharge is not economical over the rate of 20 amperes per hour. This rate of charge and discharge we will call normal. A larger rate of either we will

\* *Electrical World*.

consider maximum. We get quicker work, which is supposed to be needed, but not so economical as to efficient percentage. If it should happen that the charging current was not cut off at the end of five hours, the current that still flowed through the battery would be of no good nor do any harm. It would be like splashing water over the top of a tank after it has been pumped full.

In watching our next charging, we may find that one cell in the series does not act like the others. The surface of the electrolyte remains quiet, and no bubbles appear on the surface. We try the voltmeter on the circuit, and find that we are two volts short; instead of a fraction over 60 volts we have but 58. We must try every cell, using the double reading on our Weston voltmeter, which is divided into thirtieths and has a double-pole standard or connection fastening one wire to the small standard and one to the larger one. This will give us the reading on the lower line for two or four volts and thirtieths of a volt. Now we must find out, by testing each cell for voltage, where the loss is, testing along the line thus with two insulated wires, the ends of which are attached one to the north pole of the voltmeter and one to the south, and the other two ends cleared of the insulation and slightly sharpened. We touch the two poles of each cell, and find after several tests that one cell in the series shows a very low voltage; here must be the trouble, and after closer examination we find a contact between the plates in the battery which actually short-circuits it, and merely allows the current to pass through to the next cell, the same as if the two poles were fastened to a wire reaching across to the next cell. We must take this cell out, and as it is behind the others in the charge, must wait until they are all discharged. Then, after separating the plates, begin anew with the others. If we do not take this precaution, we shall find this cell unequally charged, and thus a drop in our E.M.F. before the battery has done its estimated work. However, when a battery is well formed and equally charged and discharged for a few days, this seldom happens until the batteries have been in use several months. But it does happen with nearly all the styles of batteries now made, and it is impossible to tell when it will take place, especially if the work the battery is forced to do demands at times a discharge in ampere current much over normal, that is 70 or 80 ampères, the tendency being to bend and twist the plates, and thus bring those of opposite poles together so that they touch. This uncertainty is what throws a shade of hazard over the calculations of those using such storage batteries, and is one of the strong objections to placing them in work demanding certainty of performance. Every effort is now being made to make batteries in such a way as to avoid this, but the writer is strongly of the opinion (and practice for one year bears him out in this) that it cannot be done unless the plates are prevented from touching each other, under any strain of work, by some fibrous absorbent that will not disintegrate in the acid nor increase the internal resistance. This the writer has accomplished, so that short-circuiting, that is buckling, cannot take place.

In order to gain this advantage the writer departs from the general mechanical method of building the batteries. Heretofore the plates in all batteries have been placed in an upright position in the cell, face to face and depending entirely upon their own atomic tenacity to hold together. Strips of hard rubber or small buttons of the same material are placed between the plates to prevent their touching each other. This method of separation often fails, especially when a heavy current tends to buckle the plates. There is also a constant tendency in the active material to flake off, or even to fall out and be held between the plates, thus short-circuiting the battery; also a danger from trees of lead, or specular crystals of lead, which form between the plates, and produce the same deleterious action, and which can not be prevented or guarded against. These crystals are very fine, almost needle-like and imperceptible. Another trouble shows itself when the plates are most active. The positive ones

become very porous and spongy, and then they fall apart and disintegrate, and the cell is ruined.

The method of building batteries, mentioned above as being an exception to the rule, is this: The plates are placed one over the other, horizontally in the cell, the positive all held together by strong lead lugs, which are cast on each plate. These lugs are hollow and tapered, and are pressed into each other firmly. The negatives are treated in the same manner. Through this continued lug a heavy copper wire is run, and molten lead poured down the lug and around the copper, thus making a firm contact, both chemically and mechanically. Then the two sets of electrodes are slid together, and a peculiar kind of cellulose fibre is placed in thin sheets between the electrodes. This fibre absorbs freely, is a non-conductor, and is of so small resistance to the passage of current or the gases formed in decomposing the water, that it cannot be detected, either in practice or by test. The fibre is of great durability in the acid, and is just close enough in its mesh to prevent any minute material from passing or washing through from one electrode to the other. Thus the plates being supported, and feeling no strains that might tend to disintegration, last much longer than other forms of battery, and when, in the course of two or three years, the positive plates may need renewing, the old ones can be drawn out, and an entire new set slid in.

It is found that the copper wire, imbedded in the lug, carries a larger amount freely, and a discharge of 80, 100 and 125 ampères does not disturb the plates.

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#### STANDARD SPECIFICATIONS FOR ELECTRICAL PLANTS.

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THE new catalogue issued by the United Edison Manufacturing Company of America, besides containing an excellent description of the Edison apparatus, embodies a form of standard specifications for electric light plants. These specifications, which we print below, are the result of a large experience in this class of work, and give a very good idea of the manner in which installing is carried out in the States.

*Dynamos.*—The dynamo must be of such type and must be so connected as to operate with the highest economy, either separately or in multiple arc (in case there be more than one dynamo), and so that in such case the load may be shifted from one machine to another up to the limit of its full load without in any way affecting the candle power of the lamps. The dynamo must be capable of being operated for 10 hours continuously under conditions of full rated load without injurious heating of any part of the dynamo and without sparking. The dynamo must be of such design that the increase in power required to operate it from least load to full load shall be proportional to the number of lamps in operation. The dynamos must have a commercial efficiency under full load of not less than 85 per cent. in dynamo, requiring three (3) horse power in belt, and of not less than 92 per cent. in dynamo, requiring one hundred (100) horse-power; and dynamos of intermediate size shall have an efficiency proportional to the efficiencies quoted. The commercial efficiency of the dynamo under conditions of one-quarter load shall not vary more than 8 per cent. from that at full load. Each dynamo must be provided with a belt-tightener, so that the tension of the belt may be altered at will while machine is in operation. The armature of the dynamo shall be perfectly balanced, so as to run at its rated speed without appreciable jar. There shall be at least two brushes on each side of the commutator. The insulation resistance between the armature and field coils and the base of the machine must be at least 200,000 ohms. Each dynamo must be placed on a solid wooden base, and must be thoroughly insulated electrically. (When operated continuously for 10 hours under conditions of full load, the temperature of no insulated wire or other

electrical portion of the dynamo shall rise in temperature more than 80° C. above the temperature of the surrounding air.) All dynamos shall be provided with self-oiling bearings, which, under normal conditions, shall not require attention, except when the dynamo is started.

*Instruments.*—Each dynamo must be provided with an ampèremeter in circuit with it, which shall show continuously the current said dynamo is producing. These ampèremeters must be constant, unaffected by any normal change in temperature, and unaffected in their readings by being placed at a distance of 6 feet or more from the dynamo. The ampèremeters must be accurate within 3 per cent.

A pressure indicator shall be furnished for each dynamo or set of dynamos operating in multiple arc. This pressure indicator must be connected so as to indicate directly and continuously the electrical pressure at the point to which it is connected. It must be constant in its readings, unaffected by normal changes of temperature, unaffected in its readings by magnetic influences at a distance of 10 feet from a dynamo, and must be so constructed that a variation of one volt will cause a deflection of the pointer upon the scale readily noticeable at a distance of 10 feet from the indicator.

A ground detector shall be provided which will indicate continuously the condition of each pole of the system as regards insulation to ground.

*Incandescent Lamps.*—Lamps furnished must be guaranteed to have an average life of six hundred (600) hours, and a corresponding economy of fifteen (15) lamps to the electrical horse-power. All lamps shall be of such uniformity when new that when operated at the voltage for which they are intended, both the power required and the candle-power of the lamp shall be within ten (10) per cent. of the rating. All lamps which give out from any fault within the first ten hours of the operation of the plant, shall be replaced by others without charge. All breakage of lamps beyond this, under normal operation of the plant, shall be considered under the guarantee as to average life. Lamps shall be furnished varying in candle-power from sixteen (16) to one hundred (100), there being at least three (3) different candle-powers between sixteen (16) and one hundred (100). Lamps of different candle-power shall require power in proportion to their candle-power.

*Pole Line.*—The pole line shall be composed of straight, select, shaved poles. All poles must be set perpendicularly, and must be thoroughly guyed, whenever necessary, to insure this result. They must be set one-sixth of their length below the surface of the ground. All poles must measure at least five inches in diameter at top, and where more than one cross-arm is required, they must measure not less than 6 inches in diameter. They must be housed and gained (*sic*). All cross-arms shall be thoroughly seasoned and free from knots, and painted. All cross-arms must be secured to poles in substantial manner, so that they shall be at right angles with line of pole and parallel with each other, and accurately fitted into gains. All poles where cut-outs are placed shall be stepped. The poles shall not, under any circumstances, be set further apart than one hundred and fifty (150) feet, and in heavy line work they shall not be set more than one hundred (100) feet apart.

*Overhead Conductors.*—The overhead conductors shall be of bare copper in systems using less than five hundred (500) volts. The pressure lines and service lines shall be insulated by weatherproof insulation. Whenever the conductors are likely to make contact with other materials than the insulators or poles (except leaves) the conductors shall be properly insulated therefrom. No overhead wire having a span of over ten feet shall be run in closer proximity to any other wire than ten (10) inches. All joints shall be made in substantial manner, so that no movement of the two ends relative to each other is possible, and so that the joint is as strong as the wire itself and makes thorough contact. All joints must be soldered. All overhead conductors exposed to influence of atmospheric electricity shall be protected therefrom by suitable lightning arresters.

In all cases where other wires are run above the conductors under consideration, a guard wire must be run to protect the latter from contact with the former.

*Wiring and Wiring Devices.*—For convenience in reference the wiring will be treated under two heads, the supply wires and the distributing wires.

No distributing circuit shall carry more than five (5) ampères. The distributing circuit shall lead from the distributing cut-outs, which shall be grouped together in cut-out cabinets at various distributing points in the building. Any doors, locks, hinges, &c., if desired for these distributing cut-outs, shall not be furnished by this contractor, but the cut-out cabinet shall be prepared ready for them by the contractor. The maximum loss in any distributing circuit not to exceed two (2) per cent. The cut-outs at each distributing point to be supplied by mains, which mains shall be so proportioned that under any conditions of normal load there shall not be a variation of pressure throughout the mains to exceed two (2) per cent. The connection to the distributing cut-outs from the mains shall be made through double pole fusible cut-outs of proper dimensions. In case current be supplied to the mains through feeders, there shall be fusible cut-outs placed at the points where the feeders join the mains, such cut-outs being placed both at the terminal of the feeder and upon the main immediately on both sides of the feeding point. All lines leaving the dynamo room shall be protected by fusible cut-outs, and in addition thereto any wire leaving dynamo room and carrying a current of more than five (5) ampères shall have a switch in circuit with it. In all moulded or concealed wiring where insulation of the wire makes contact with material other than special insulating material designed for the purpose, a wire of following makes, or equally as good grade and acceptable to the purchaser, shall be used: Edison Machine Works, Grade 3, Habirshaw, Okonite, Grimshaw, Kerite, Clark Safety Insulator. In the case of cleated work, where the wire will never, under normal conditions, be exposed to any moisture, an insulation of the quality known as weather-proof can be used, such as the following or their equivalent: Edison Machine Works, Grade 1, P. & B., K. K., Roeblings's Weather-proof, Ansonia Brass and Copper Co.'s Weather-proof. In all work in connection with the wiring, the wire must invariably be handled so that if the wire were bare the insulation would be the highest possible under the conditions. In other words, the insulation must not be relied upon any more than is absolutely necessary. No wire smaller than No. 18, Birmingham Wire Gauge, or No. 16, Brown and Sharp's Gauge, shall be used. In all cases the ampère capacity of the conducting wires must be carefully determined, and the size of the wires so proportioned that the maximum current carried by them under normal conditions shall not occasion a rise in temperature exceeding sixty (60) degrees Fahrenheit. The wiring must be done in such a manner that in case a different system be used from that originally contemplated, there will be the least possible expense involved in changing the wiring to adapt it to any other system. All joints must be made in substantial manner, so that no movement of the two ends relative to each other is possible, and so that the cross-section of contact is at least twice the cross-section of the conductor. All joints, except when surfaces are held in contact by strong pressure, such as by screws, shall be well soldered and well taped. In all cases where the wire is concealed from view the joints shall be thoroughly covered with some first-class waterproof compound before being taped. All wires that pass through floors or that rest against any metal work shall be protected by a tubing of hard rubber extending at least one inch in each direction beyond such floor or metal work. With all safety devices open, the insulation of any single section of the wiring shall not be less than 100,000 ohms. The combined insulation resistance, when all sections are connected up for service, shall be the highest obtainable when each section measures 100,000 ohms. Metallic staples for fastening wires shall not be used unless there be placed between the insulation of the wire and the

staple some insulating and non-combustible material. Electric light fixtures or gas fixtures carrying electric light wires, if attached to gas pipes, must be insulated therefrom by insulating joint or other suitable means, so that there shall be a high electrical resistance between such electrical light wiring, such fixtures and the system of gas pipes. The wiring must be so proportioned that the maximum variation of electrical pressure at the lamps in different parts of the building under any normal conditions shall not exceed two (2) per cent. All wiring must be neat in its mechanical appearance and arrangement. All points in regard to wiring not above specified shall conform strictly to the requirements of the National Board of Fire Underwriters. All cut-outs shall be made of insulating and non-combustible material, such as porcelain, glass, &c., and shall be double-poled. All switches shall be mounted upon insulating and non-combustible bases, and if covered, shall be so designed that the switch is merely set by hand ready for the break in contact, and the actual breaking of contact shall be done automatically and beyond hand control. The act of making and breaking contact in all switches shall cause the surfaces in contact to be subjected to sliding friction in order to keep such surfaces of contact clean. All sockets shall be of same dimensions relative to the base of the lamp, so that any standard Edison lamp of any candle-power will fit any socket. The socket shall be of substantial, workman-like construction, and all portions of the shell and key shall be thoroughly insulated.

### DIRECTORS' LIABILITY.

LEST our readers should imagine that we have inspired Public Bill No. 300,\* at this present moment worrying itself through its stages in the Imperial Parliament, we hasten to disclaim the honour. "A Bill (as amended by the Standing Committee on Trade) to amend the law relating to the liability of directors and others, for statements in prospectuses and other documents soliciting applications for shares or debentures," is prepared and brought in by Mr. Warmington, Mr. David Thomas and Mr. Neville, who deserve the thanks of all investors for raising the question. Its advent is not too early in the day of joint stock association, and no one can accuse it of not being sufficiently drastic or unnecessarily long. It contains four clauses:—The first, the title; the second, intimating that it is to be construed with the other Companies Acts; and the fourth, as amended, that it shall come into operation on the first day of October, 1890. Until that date directors have a close time, and may be expected to evolve prolifically. One clause only, clause 3, forms the body of the Bill; but this one is sufficient to make directors *in posse* "sit up."

Where a prospectus or notice invites persons to subscribe for shares in or debentures or debenture stock of a company, every person who is a director of the company at the time of the issue of the prospectus or notice, and every person who is named in the prospectus or notice as a director of the company or as having agreed to become a director of the company either immediately or after an interval of time, and every person who has authorised or is responsible for the issue of the prospectus or notice, shall be liable to pay compensation to all persons who shall subscribe for any shares, debentures, or debenture stock for the loss or damage they may have sustained by reason of any inaccurate or misleading statement in the prospectus or notice, or in any report or memorandum incorporated therewith or referred to therein, unless he proves—

(a.) With respect to every such inaccurate or misleading statement of fact not purporting to be made on the authority of an expert, that he made reasonable inquiry and examination into the statement and had reasonable ground to believe, and did then and up to the time of the allotment of the shares, debentures, or debenture stock, as the case may be, believe that the statement was true; and

(b.) With respect to every statement or extract purporting to be a statement of, or an extract from, any report or valuation of any engineer, valuer, accountant, or other expert, that it was a true and fair statement of, or extract from the report or valuation, and that the report or valuation was made by the person whose name

\* This Bill has passed for third reading.

it bears, and that he had reasonable ground for believing, and did then and up to the time of the allotment of the shares, debentures, or debenture stock, as the case may be, believe, that the report or valuation was made in good faith, and that the person making it was competent to make it; or unless he proves that he had not consented to be become a director of the company, or that having so consented, he withdrew his consent before the issue of the prospectus or notice, and that the prospectus or notice was issued without his authority or consent.

It is possible that the gentlemen who back the Bill are not intending to set up in the directorial line, for that line, if the Bill were to become an Act as it stands, would not fall in pleasant places. However wisely we may have loved the director, it has not been our lot to love him too well; but in his hour of trial we beg to extend him our sympathy. We read in the daily press that Mr. Warmington has been warmly congratulated on his Bill. Possibly, but by whom? Not by directors surely, nor by anybody who has seriously considered the question with a full knowledge of the subject. We are inclined to agree with Sir Roper Lethbridge who, in moving an amendment, remarked that the whole Bill is in a chaotic condition. Supposing it to have become law as drafted, no sensible man would be a director, nor would any respectable office boy's mamma allow her son, on leaving the Board school, to serve the Board room, for "others," defined as "every person who is responsible for the issue of the prospectus," would seem to include the secretary, solicitors, bankers, auditors, clerks, boy, porter, and possibly the printer and postman. We have heard of men who, sighing for some one willing to incur the expense of making them bankrupts, sighed in vain. To this class we should have to look for directors—to those who have nothing to lose; and the last state of the shareholders would be worse than the first. The most common sin of directors is ignorance of the business they have to direct; but this very ignorance is to some extent often a necessity and pleadable as an extenuating circumstance; relying on "experts," they have not all the knowledge to enable them to judge who is an expert and who is not. As amended, the word "expert" is to include any person whose official or professional knowledge gives authority to a statement made by him. Another amendment is, that a director is to be exempted from liability where he has reasonable grounds for believing a report or valuation was made by the person whose name it bore, after reasonable enquiry and examination.

It would not be well for companies that men of means should be afraid to accept seats on boards. There are plenty of company directors in both Houses, so let us hope a workable measure will be finally turned out at which all honest men may rejoice.

Promoters of traction companies please note.

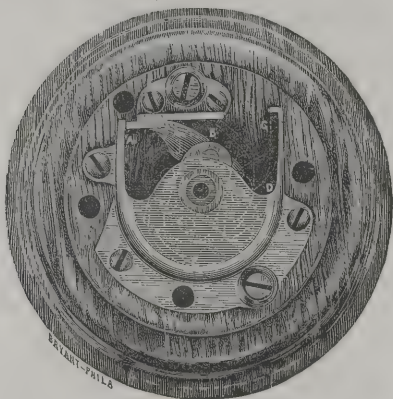
### THE PAISTE SWITCH.

WE illustrate in our columns to-day a novel switch designed and patented by Mr. H. T. Paiste, of Philadelphia, Penn., U.S.A. This switch has met with deserved success in America, where over 100,000 are in daily use, and judging from a number of letters which Mr. Paiste was good enough to show us, it has evidently been adopted by all the leading electric companies of that country.

Mr. A. Reyrolle, of London, has secured the European rights to manufacture and sell this switch, and has furnished us with the following description:—

It was the object of the inventor to abandon the use of spring metal for electrical contact, as practice had demonstrated that metal soon lost its elasticity when under the action of electric currents, and with this in view he used two plates (made from sheet brass), one U-shaped, the other being straight. These are shown in the accompanying cut, mounted on a base of non-conducting material. The binding screw on U-shaped plate is the terminal of one circuit wire, and the screw on straight plate the terminal of the other. Two arms,

A and D, are hinged to a spindle, the bearing of which is located in the centre of U-shaped plate. A spring joins the end of the two arms, which keeps the arm, A, pressing firmly against the straight plate, also the arm, D, against the U-shaped plate. As shown in the cut, the circuit is completed as the arm, A, joins the U-shaped plate and the straight plate, through its spindle and the arm, D, also at its point. To break circuit, the spindle is turned (by means of a handle screwed into its centre) to the right a quarter turn; by so doing the arm, A, slides along the straight plate (cleaning it) until the position, B, is reached (while the arm, A, slides along the straight plate it is lengthening the spring), at which point the straight plate becomes the tangent of a circle, of which the arm, A (hinged on the spindle), becomes the radius. As soon as the straight plate becomes the tangent, the arm, A, flies rapidly to position shown at C, when the circuit is broken. Whatever arcing there is is on back of arm and not on face where electrical contact is made. The



circuit is completed by a like movement, the arm, D, coming to rest in position shown by A. Each time the switch is used better contact is secured, as the arm seats itself in the straight plate, like a hammer blow. This switch, in various sizes, is now being mounted on china, with cover and handle of same material, making a small, neat and artistic fixture.

The Electric Supply Company, of Chicago, state that they have sold several thousands of Mr. Paiste's snap switch, and never had one returned nor a single complaint. A letter from the Sawyer-Man Electric Company, New York, says that they have sold thousands of the 10 ampère single-pole switch, no complaints having reached them from any quarter; one from the Central Thomson-Houston Company, Cincinnati, is as follows:—"Having used several thousands of your switches, it gives us pleasure to be able to give them our hearty endorsement, and you are at liberty to refer to us at any time." The New England Electric Supply Company, Bridgeport, writes:—"We take much pleasure in saying that in our opinion the Paiste switch is incomparable. Of the thousands that we have sold, not one has been damaged either by burning or owing to mechanical defect. The economy in using the switch is obvious, while certainty of its action is of the utmost value." Central Electric Company, Chicago, say:—"We have handled many thousands of the Paiste switch, and we know of no complaints; on the contrary, our customers speak of it in terms of praise." Mr. Paiste showed us dozens of other testimonials to a similar effect.

**Storms and Electric Wires.**—It has for some years been the practice at the Berlin Post Office for the *employés* to make a note of storms and magnetic disturbances, direction of storms, length, &c., and the result has demonstrated that underground wires, without being entirely free from the influence of magnetic storms, are much less liable to disturbance than overhead ones; and, on the other hand, that accidents from lightning are much less serious in those towns where the overhead system is in vogue.

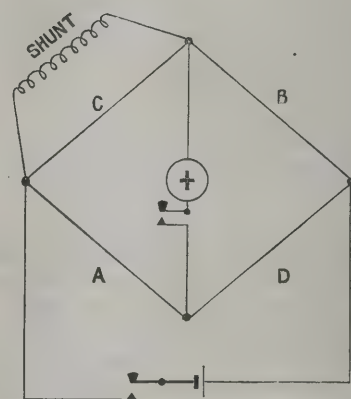
## ACCURATE MEASUREMENT OF LOW RESISTANCES.

EVERYONE who has had occasion to use the Wheatstone bridge, with the mirror galvanometer, for the purpose of measuring small resistances has suffered from the inconvenience and difficulty consequent on inexact balance, even when unequal arms are used.

Recently finding it necessary to obtain a very accurate adjustment with the bridge, with arms of equal resistance and not exceeding 100 ohms each, the minute differences of resistance existing between the arms, although nominally equal, rendered an accurate balance impossible.

The use of fine wires, sliding contacts and various other devices were tried, without any satisfactory result.

It then occurred to me to shunt one of the higher resistance arms with an adjustable resistance very much greater than itself, and this was found to be perfectly successful; alterations of the shunt, enabling a perfect balance to be obtained, although the conditions were such that a difference of  $\frac{1}{100000}$ th in the joint resistance of the shunted arm produced a deflection of one division.



This mode of attaining the condition of perfect balance has no doubt suggested itself to others, but does not appear to have been published before and it may be of service to draw attention to it now.

It is clear that it is not only useful in attaining a perfect balance with some predetermined fixed resistance, but may be employed in the exact determination of small fractions of an ohm which are now less accurately estimated by using arms of unequal resistance.

If determinations to  $\frac{1}{1000}$ ,  $\frac{1}{10000}$  or  $\frac{1}{100000}$  are required, the shunt should be respectively 1,000, 10,000, or 100,000 times the arm resistance, and it may be used to determine a resistance which by that amount is in excess of, or is less than, the resistance unplugged in the measuring arm.

For *plus* results in D the shunt should be placed across the arm A, and for *minus* results across the arm C; and it will be found in practice that this method admits of very exact measurements with great ease of manipulation.

A. EDEN.

## SHAPING FILAMENTS OF INCANDESCENT LAMPS.\*

WHEN the loop-shaped filaments of incandescent lamps are straightened by a weight during the period in which the air in the bulb is exhausted, the removal of the weight is found to be a rather delicate operation. In straightening the filaments in this manner it has

\* *Western Electrician.*

ordinarily been found necessary to attach to each lamp bulb an exhaust tube longer than usual. After the operation of exhausting has been completed, this tube is first sealed some distance from the globe, and the lamp removed from the pump. By manipulating the lamp the weight is unhooked from the loop and dropped into the tube, which is then sealed off from the lamp. The accompanying diagram illustrates an improved method of handling the weight by magnetism. A glance at figs. 1 and 2 will show the simplicity of the operation. The small weight shown

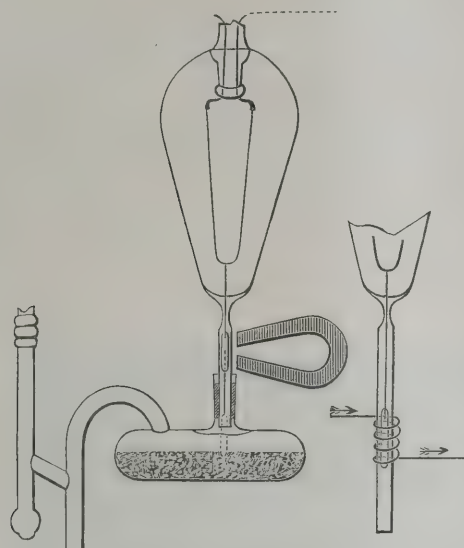


FIG. 1.

FIG. 2.

in the tube and hung on the filament is made of iron or other magnetic material. By this construction it is only necessary to use a magnet, as shown in fig. 1, or a solenoid, as indicated in fig. 2, and the weight may be manipulated as desired. It is evident, too, that the magnetism of the solenoid or permanent magnet may be employed to increase or diminish the strain or pull on the weight. This insures a delicacy of adjustment otherwise unattainable. This method of weight manipulation in the above-mentioned process is the invention of R. N. Dyer of New York.

### NEW MARINE SIGNALLING APPARATUS.

A NEW mechanical apparatus, in which electricity plays a part for night operations, has been invented by Mr. R. J. Crowley, for marine signalling purposes. The apparatus may be fixed to any top-mast, and consists of a hollow iron mast, from the right and left-hand sides of which project horizontally four oblong metal frames. Each of these contains two shutters, which in their normal position are horizontal, and which are mounted on axes so that they may be revolved. One side of each pair of shutters is painted vertically with red and white stripes, whilst the other side forms a white diamond on a dark ground. At the inner end of each shutter is fixed a recessed pulley over which passes a chain which on being pulled grips the pulley and causes the shutter to revolve. Only four working chains are required, the lower pulley of each frame being operated by a subsidiary chain suspended from its corresponding operating chain. The working chains are carried to the bottom of the iron mast, where they are joined to wire ropes extending to the deck of the vessel, or any other desired part thereof. The shutters represent the alphabet, and also certain signals. Thus on causing any shutter, or combination of shutters, to be exposed by pulling any one or more chains, any letter or words may be flashed. The four wire ropes are fastened to horizontal levers, so that by depressing or raising any one lever any message may be signalled. The operator has only in front of him the four levers and a card

upon which the code is printed. Signals may be transmitted with this apparatus with great rapidity, and by a mere tyro.

The electrical part of the apparatus comprises four electric lamps fixed at the four corners of the frames, and is only used for night signalling in conjunction with the same code. The four lamps are backed by coloured reflectors, and are connected with a battery or dynamo, as the case may be, through make and break switches. Thus on depressing any switch its corresponding lamp is placed in circuit and lighted, whilst on releasing the switch the light is extinguished. By this means any signal may be flashed. A fifth electric lamp is also fixed on the apparatus, and is used purely for lighting purposes. A company will shortly be formed to work this invention, which is of American origin. Further information will be furnished by Messrs. Salter, Hunt and Co., of 62, King William Street, E.C.

### SEEING BY ELECTRICITY.

THE exhibition, at the Jubilee of the Penny Post, held at the South Kensington Museum, of an apparatus called the electrophonoscope, though it no doubt answered the amusing purpose of a penny peep-show, did not advance, it is perhaps needless to say, the problem of seeing by electricity a single stage. The apparatus was, we believe, nothing more than a well-arranged combination of a telephone and the well-known optical delusion which enables the intelligent rustics at the country fairs to "see through a four-inch deal board," or through one of their companions equally hard craniums. In fact, as regards the "seeing" part of the apparatus, there was nothing electrical about it, except the illumination of the reflectors by incandescent lamps. It is now some years since the late Robert Sabine, Profs. Ayrton, Graham Bell, and others suggested that the problem of "seeing by electricity" might be partially solved by the aid of a series of selenium cells, arranged in a mosaic pattern, and upon which an image of the subject to be transmitted was projected; but no practical result seems to have developed from the crude idea. Edison, we hear, is working away at the question, but whether he has arrived at an approximation to a solution anything more definite than mere rumour does not indicate. An announcement that success had been attained would of course be heralded in the daily press by the usual stereotyped announcement of a "revolution in telegraphy, the far-reaching consequences of which it is impossible to estimate," words which, as regards the latter part of the statement are, no doubt, strictly true, as the almost invariable falsification of the prediction shows the inability of the "dailies" to estimate correctly the value of scientific discoveries. One great direct practical value of a really successful method of electrical vision would be great rapidity of telegraphic transmission, as—unlike the telegraph and the telephone, where the communication of intelligence is the result of a sequence of expressions one following after the other, and which, consequently, takes up time—seeing by electricity means the simultaneous transmission of the facsimile of all parts of a picture or object, which would be visible to an almost unlimited number of spectators; consequently, a long written or printed message, if made visible, could have its several paragraphs copied down each by a different person, and all writing at the same time.

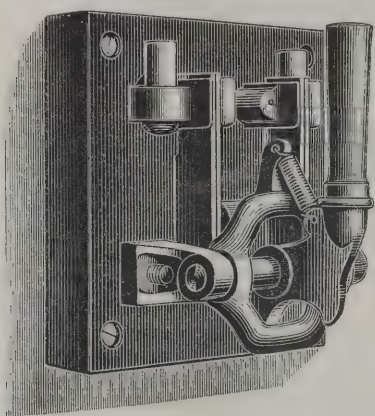
**The Post-Office Jubilee.**—The celebration reception and exhibition on Wednesday night, under the Presidency of the Duke of Edinburgh, seems to have been entirely successful. The feature which excited the greatest interest was the electrophonoscope show, a little delusion which reflected great credit upon its learned originators, and which caused many persons to go away under the impression that seeing by electricity has become an accomplished fact.

## NOTES.

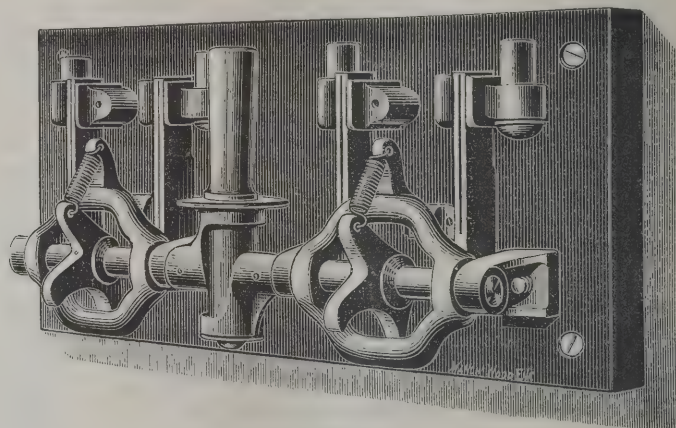
**Electrical Measuring Apparatus.**—In the report on the Weymersch battery, which we published last week, the names of Messrs. Sharp & Kent were inadvertently omitted from the list of those firms who so obligingly lent the testing instruments.

**Automatic Electrical Call Boxes.**—We understand that a similar call box to the one referred to in our issue of the 13th ult. has been patented in Germany, and that it is already in use in Breslau, Hamburg, and Berlin. It is very probable that one of this make will be shown in London in two or three months hence.

**Main Switches.**—Yet another series of switches, this time of the main or switchboard type, is about to be introduced by Messrs. Dorman and Smith, of Manchester and London. There is nothing strikingly novel about these switches, their principal characteristic being their extreme solidity. The illustrations show these arranged for use both for "single" and "double" pole. They are at present made in four sizes in both



SINGLE POLE SWITCH.



DOUBLE POLE SWITCH.

types, are of gun-metal, with steel shafts, and are mounted on slate slabs. They have a double break, good spring contacts, and instantaneous release, and being fitted with conical thimble terminals, arranged either on the front or back, are easy to couple up.

**Telephone Call Boxes.**—We are informed that in a few months telephone call boxes will be installed in various London districts, so that persons desiring to communicate with the exchange and then to subscribers may do so. The money to be paid for conversation will be deposited in slots, when the exchange may be rung up. Subscribers will, however, each be provided with a key which will fit into holes in the boxes, and by means of contacts inform the exchange attendant that the person desiring to communicate is a subscriber. Of course, the latter will not have to pay any fee other than his annual subscription.

**Death of the Swiss Director of Telegraphs.**—The death is announced of Herr Frey, Director of the Swiss International Telegraph Bureau, who was only recently appointed.

**Prize.**—The Société d'Encouragement pour l'Industrie Nationale has awarded to M. Gramme the Ampère medal.

**Messenger Call System.**—To advocate the claims of this system a conversation will take place at the Royal Institute of Painters in Water Colours on July 12th.

**An Error.**—Messrs. Crompton & Co. correct our statement made last week as to the price per unit at Chelmsford. It should be 1s., not 1s. 3d.

**The Tory Island Cable.**—The steamer *Buccaneer* left Silvertown on Wednesday to lay the cable connecting Lloyd's signal and telegraph station on Tory Island with the mainland.

**Corporation of Salford v. Lever.**—The judgment given against Mr. Lever at Leeds last month was upheld in the Queen's Bench Division on Saturday. It was intimated that there would be an appeal.

**Arc Light and Battery Carbons.**—A point brought out in the discussion upon Mr. Marks's paper on "Arc Light Carbons" at the recent meeting of the American Institute of Electrical Engineers, had reference to the control of the arc by means of a small energised coil in suitable proximity to it. According to Mr. Marks, it is possible in this way to maintain a perfectly steady, noiseless arc, and Prof. Thomson's experience supported this view. An American contemporary, however, thinks it doubtful, if the method possesses the requisite simplicity for commercial purposes. Our contemporary thinks also that the suggestion made by Mr. Pope at the same meeting, that some competent student should take up the study of battery carbons, should be acted upon, as it would result in the discovery of many valuable principles, and in the confirmation of many of the now accepted theories in connection with the battery carbon.

**Technical Education.**—At the Department of Science and Art of the Committee of Council on Education, South Kensington, a letter from Mr. J. W. Pye-Smith, Town Clerk of Sheffield, dated 16th May, 1890, was read, stating that the Town Council of that borough propose to make grants, under the powers conferred upon them by the Technical Instruction Act, 1889, to certain institutions in Sheffield for the promotion of technical instruction; that at one of these institutions instruction is given in the following subjects, which are not included in the branches of science and art, with respect to which grants are at present made by the Department of Science and Art, viz.:—1. Manual training or instruction in the use of tools for working in wood and iron; 2. Plumbers' work; 3. Electrometallurgy; 4. French; 5. German; 6. Type-writing; 7. Shorthand; and that, in the opinion of the Town Council, such a form of instruction is required by the circumstances of its district. In accordance with the request of the Town Council, the Lords of the Committee of Her Majesty's Most Honourable Privy Council of Education have been pleased to sanction this form of instruction under clause 8 of the Technical Instruction Act, 1889, for the borough of Sheffield, and this minute will be laid before Parliament in accordance therewith.

**New Business.**—Messrs. Pollock and Macnab, of the Britannia Iron and Engine Works, Hyde, near Manchester, announce that they have opened a new department in their business, that of electrical engineering. They have engaged as practical superintendent a specialist of large experience in some of the largest electrical engineering establishments in the Kingdom, and are therefore in a position to make electrical machinery and plant for electric lighting. They solicit a visit to see the plant they have put down for themselves.

**Electric Lighting Orders.**—Mr. O. V. Morgan asked the President of the Board of Trade whether the effect of the provisions which the Board had inserted in electric lighting orders now before Parliament, authorising local authorities to transfer their undertakings, would be practically to confer upon the Board of Trade powers to perform functions heretofore exercised by Parliament, and also deprive the public of the means that they now had of resisting any such transfer by appearing before a Parliamentary Committee where evidence was taken upon oath; and whether the Board would have the power to administer an oath if the functions of Parliament were so vested in that department. Sir M. Hicks-Beach: Section 11 of the Electric Lighting Act, 1882, provides that "no local authority, company, or person shall by any contract or assignment transfer to any other company or person or divest themselves of any legal powers given to them, or any legal liabilities imposed on them by this Act, or by any license, order, or special Act, without the consent of the Board of Trade." The provisional orders granted under the Act referred to require that public notice of the proposed transfer shall be given, and the transfer cannot be made without the consent of the Board of Trade, by whom the deed of transfer must be approved, and who will make any enquiries that they may consider necessary in the interests of the public. The Board of Trade would have no power to administer an oath. With regard to the merits of the clause, I wish to point out that the local authorities, who are representatives of the ratepayers, ought to be the best judges of their interests in matters affecting the lighting of the town.

**The Halifax and Bermuda Cable.**—A cablegram has been received by the Halifax and Bermuda Cable Company from the ss. *Westmeath*, in lat. 35° 11 min., long. 64° 7 min., stating that at noon on the 29th inst. 623 knots of the cable had been paid out, and that the steamer was now well past the influence of the Gulf Stream. Weather fine and everything satisfactory. The cable was completed on Tuesday last, and Messrs. W. T. Henley's Telegraph Works Company, Limited, are to be congratulated on the success they have met with in laying the new cable. A large number of soundings were taken, the bottom being found even and quite satisfactory; the greatest depth ascertained was 2,820 fathoms. The paying out of the cable was commenced on Wednesday, the 25th ult., and the ship arrived off Bermuda at noon on the 30th.

**New Companies.**—We understand that no less than 100 new companies have been registered during the past week. As may be seen in our columns a goodly proportion are electrical.

**A Financial Paper's Views.**—The *Financial Times*, speaking of the Okonite scheme, says:—"Before English capitalists rally round a concern intended to combine an American with an English business, they will want something a little more satisfying than a report by one of the English vendors on the American property, and by the American vendor on the English property, and those furnished by Mr. F. L. Rawson and Mr. F. Cazenove Jones respectively are the sole grounds on which the International Okonite Company bases its appeal to the public."

**More Newspaper Science.**—In the evening edition of yesterday's *Standard* it is gravely asserted that the power of the electrophonoscope to reproduce images is due to the employment of selenium, "whose capacity to transmit sunlight pictures has long been known to scientific men." If it is not too expensive, says our daily contemporary, we shall ere long find it in every office where a telephone is employed. We thought that the *D. T.* and another were the only papers which Messrs. Hughes, Preece and Stroh had fooled, but it is painfully evident that the "Technical and General News Agency," to which we referred last week, is more than ever a necessity of the *Times*.

**Manufacture of Double Carbon Lamps.**—The Brush Company, of Cleveland, has obtained an injunction against the Sperry Electric Company covering the manufacture or use of double carbon lamps. This is the fourth decree obtained by the Brush Company on this patent.

**Okonite.**—In 1886 a Mr. Smith, who was exhibiting in London the manufacture of okonite, gave a piece of the material to an electrical firm, who submitted it to a well-known analyst, whose report was as follows:—

Rubber	...	...	...	49.60	per cent.
Sulphur	...	...	...	5.30	"
Lamp Black	...	...	...	3.20	"
Zinc Oxide	...	...	...	15.50	"
Litharge	...	...	...	26.30	"
Silica	...	...	...	0.10	"
				100.00	

**Personal.**—Mr. Charles F. Quicke, works manager of the establishment of Messrs. Immisch, electrical engineers, of Kentish Town, was installed Worshipful Master of the Chislehurst Lodge of Freemasons, No. 1,531, at Chislehurst, on Saturday last, in the presence of a large number of metropolitan brethren.

**The Electrophonoscope.**—"This remarkable instrument will be exhibited for the first time at the Post Office Jubilee *soirée* at the South Kensington Museum. It is the joint invention of Prof. Hughes, F.R.S., Mr. Preece, F.R.S., worked out by Mr. Ströb, and Mr. Roberts, one of the Post Office officials. It solves the question of visual telegraphy. The sender of a message from a distant station appears in person before his correspondent, and with a telephone it is possible not only to speak to him, but to see him, and to watch the expression of his features. It is a perfect complement to the telephone, and will illustrate what telegraphy is likely to be in 1990." The above is the official description of the apparatus, which we have dealt with—we hope as it deserves—on another page.

**Electric Lighting in St. Pancras.**—Prof. Robinson has extended the time for receiving tenders for the various contracts. At a recent meeting of the vestry a letter was read which stated that the County Council had decided to advance the vestry a loan of £10,000.

**The Institution of Electrical Engineers.**—The Secretary sends us the following communication:—"Referring to the circular in regard to the Edinburgh meeting, issued by me to members of the Institution on the 25th ult., to which you were good enough to draw attention in your columns, I shall feel greatly obliged by your mentioning in your next issue that both the London and North-Western and the Midland Railway Companies have consented to issue to any of our members who may be proceeding to the meeting return tickets of any class, available for eight days, at the same reduced price as has been agreed to by the Great Northern Railway Company, viz., at a single fare and a quarter. The tickets will be issued from any of the stations of these companies' lines on production of a note signed by me, respecting which I shall in a few days issue to all who may have intimated their intention to attend the meeting, and who already number over one hundred, a circular, accompanied by a programme of the proceedings.

**Hammersmith and Fulham Electric Lighting.**—At a meeting of the London County Council on Tuesday last, the Parliamentary Committee reported that the Board of Trade had intimated to the Parliamentary agents that this order would not be proceeded with.

**Electrical Plant.**—Mr. Lea's successor, as editor of this monthly trade journal, is Mr. E. R. Dolby, A.M.I.C.E.; this gentleman has, on various occasions, contributed technical descriptions of electrical apparatus to the columns of the *REVIEW*, and we wish him prosperity.

**Admiral Colomb to be Rewarded.**—Lord G. Hamilton stated in the House of Commons on Tuesday, that the Government had decided to offer Admiral Colomb a further sum of £2,000 for his services in connection with the flashing signals used in the Navy.

**A Slight Drop.**—In the Fowler-Waring mains, on which the Deptford central station at present depends, the loss, with the load now in use, amounts to 1,200 volts.

**The Brighton Electric Light Wire Accident.**—On the appeal of the Brighton Electric Light Company against the damages awarded to Mrs. Garman for the death of her husband, the damages were reduced to £500.

**Cable Manufacture in Italy.**—Messrs. Pirelli & Co., whose works last year were almost at a standstill, are negotiating with the Italian Government for another cable which it is proposed to lay in Italian waters.

**The Electric Light in Preston.**—Provisional orders were issued on Wednesday morning authorising the National Electric Supply Company and the Lancashire and Cheshire House-to-House Electricity Company to supply various parts of the borough of Preston with electricity. These orders have yet to receive the sanction of Parliament.

**Personal.**—Mr. A. E. Mavor, M.I.E.E., at present electrical engineer to Messrs. Denny & Brothers, Dumbarton, has been appointed general manager of the Fowler-Waring Cables Company, Limited, of 85, Queen Street, Cheapside.

**Telpherage at Edinburgh.**—The telpher line at the Edinburgh Exhibition was opened last week on the occasion of the visit of the Lord Mayor of London. It has been made by the Electric Construction Corporation, who are, we understand, engaged upon a telpher line through the Via Flaminia, Rome, which is expected to be opened very shortly.

**Elmore's Patent Copper Depositing Company.**—This company has now on exhibition, at 56, Queen Victoria Street, an interesting collection of specimens of seamless copper tubes, seamless copper cylinders, high conductivity wire and other products made under the company's patents upon a commercial scale at their works in Leeds. Some tests of copper deposited by this process were recorded in our issue of June 14th, 1889.

**Electric Launch Building.**—We are informed that the boat building business hitherto carried on at Strand Works, Chiswick, by Mr. Sargeant, the builder of the well known *Viscountess Bury*, has been acquired by Woodhouse and Rawson United, Mr. Sargeant's services being retained as manager of that department of the business.

## NEW COMPANIES REGISTERED.

**Thetford Electric Light and Power Co., Limited.**—Capital £5,000 in £10 shares. Objects: To carry on in all branches the business of an electric light and power company. Signatories (with one share each): \*C. Burrell, jun., \*R. G. Burrell, \*F. J. Burrell, J. Houchen, F. V. Houchen, T. Lumley, all of Thetford, Norfolk; \*W. Jackson, Knottingley, York. The signatories denoted by an asterisk are the first directors; qualification £50 in shares or stock. The company in general meeting will determine remuneration. Registered 23rd inst. by Mr. R. Jordan, 120, Chancery Lane. Registered offices, St. Nicholas Street, Thetford, Norfolk.

**International Okonite Company, Limited.**—Capital, £340,000 in £10 shares. Objects: To manufacture insulated and other wires and cables for telegraphic, telephonic, and other purposes, and for such purposes to adopt an agreement with Woodhouse and Rawson

United, Limited. To carry on business as electricians. Signatories (with 1 share each): F. Spooner, 83, Rendlesham Road, Lower Clapton; J. Beaumont, 9, Daneville Road, Camberwell; H. E. Smith, 26, Park Place, Leyton; H. C. Newton, 121, Avenell Road, N.; J. S. Stornden, 60, Moray Road, N.; W. Daune, 6, Lexham Gardens, W.; A. Stevens, 4, Trafalgar Square. The first English directors will be appointed by the subscribers; remuneration, £1,500 per annum, and in addition 3 per cent. on all net profits other than profits derived from the American branch of the business. There will be a committee of management in America, the first members of which are F. Cazenove Jones, H. Durant Cheever, W. L. Candee, J. H. Cheever, and H. Martin; remuneration, 5 per cent. on all net profits resulting from the American branch of the business. Qualification for subsequent directors, 50 shares or £500 stock. Registered 24th ult. by Parker, Jarrett and Parker, St. Michael's Rectory, Cornhill.

**S. Z. de Ferranti, Limited.**—Capital, £100,000 in £10 shares. Objects: To purchase any business or patents relating to electricity. Signatories (with 1 share each): \*S. Z. de Ferranti, \*H. P. Sparks, Charterhouse Square; \*F. Ince, J. B. Ince, St. Benet Chambers, Fenchurch Street; T. W. Hunter, 2, Dashwood Road, Stroud Green; A. Wright, 3, Clermont Road, Brighton; H. W. Kolle, Egremont, Tulse Hill. The first three signatories are appointed directors; qualification, 100 shares; the company in general meeting will determine remuneration. Registered 26th ult. by Ingledew, Ince and Colt, St. Benet Chambers, Fenchurch Street.

**Woolwich District Electric Light Co., Limited.**—Capital £10,000, in £1 shares. Objects: To carry on the business of an electric light company in all branches. Signatories (with 20 shares each): J. T. Randall, A. W. Mellish, Robt. Webb, R. B. Dale, G. H. Campbell, G. Whale, W. H. Pryce, all of Woolwich; J. R. Jolly, J.P., Plumstead. Registered without special articles by G. Whale, 54, Cannon Street.

**Canterbury Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: To carry on the business of electrical engineers and suppliers of electrical apparatus, mechanical and chemical engineers. Signatories (with 1 share each): Emile Garcke (Manager and Secretary Brush Electrical Engineering Company, Limited); J. L. Raworth (engineer); W. C. Mann, R. A. Dawburn (electrical engineer), W. M. Mordey (electrician), R. Percy Sellon, W. Geipel (electrical engineer), all of 112, Belvedere Road, Lambeth. Most of the regulations of Table A of the Companies' Act, 1862, apply. Registered 28th ult. by Sydney Morse, 4, Fenchurch Avenue, E.C.

**Cardiff Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: To carry on the business of electricians in all branches. In this and following six companies the signatories are the same as in the preceding company. Registered 28th ult. by Sydney Morse, 4, Fenchurch Avenue.

**Henley Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: To carry on business as electricians. Registered 28th ult. by Sydney Morse, 4, Fenchurch Avenue.

**Ipswich Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: To carry on business as electricians. Registered 28th ult. by Sydney Morse, 4, Fenchurch Avenue.

**Loughborough Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: To carry on business as electricians. Registered 28th ult. by Sydney Morse.

**Manchester Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: Electricity in all branches. Registered 28th ult. by Sydney Morse.

**Penzance Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: To carry on business as electricians in all branches. Registered 28th ult. by Sydney Morse.

**Weymouth Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: Electricity in all branches. Registered 28th ult. by Sydney Morse. The registered offices of the above companies are at 112, Belvedere Road, Lambeth.

**Kidderminster Electric Light and Power Supply Company, Limited.**—Capital £1,000, in £1 shares. Object: To carry on at Kidderminster or elsewhere the business of an electric light and power company in all branches. Signatories (with 1 share each): C. S. Peach, 8, John Street, Adelphi, architect; E. Bax, Eltham, Kent; C. Roberts, C.E., 6, Gray's Inn Place; J. R. Cleave, Hotel Windsor, Victoria Street, S.W.; E. J. Jennings, 13, Victoria Street, engineer; R. Thicknesse, 11, Abchurch Lane; T. B. D. Cooper, 5, Victoria Street, engineer. The subscribers are to appoint the first directors. Qualification, £50 shares or £50 stock. Remuneration, £200 per annum to the chairman, and £100 per annum to each director. Registered 28th ult. by Fox and Thicknesse, 11, Abchurch Lane.

**East Coast Electric Light and Power Company, Limited.**—Capital £1,000, in £1 shares. Objects: To carry on in the towns of the East Coast or elsewhere the business of electric lighting. The signatories for one share are the same as in the preceding company, and the same arrangements for directors also apply. Registered 28th ult. by Fox and Thicknesse.

**Devonshire Electric Light and Power Company, Limited.**—Capital £1,000, in £1 shares. Objects: To carry on in Devonshire or elsewhere the business of electric lighting in all branches. The signatories are the same as in the two preceding companies, and the same regulations as regards directors also apply. Registered 28th ult. by Fox and Thicknesse.

**Camberwell and Islington Electric Light and Power Company, Limited.**—Capital, £1,000 in £1 shares. Objects: To carry on in the parishes of Camberwell and Islington the business of electric lighting. The signatories of the three preceding companies take one share each in this company. The same regulation for directors also apply. Registered 28th ult. by Fox and Thicknesse.

**Stamford Hill, Tottenham and Edmonton Electric Light and Power Company, Limited.**—Capital, £1,000 in £1 shares. Objects: To carry on in the neighbourhoods mentioned in title the business of electric lighting. The signatories of the four preceding companies subscribe for one share each in this company, and the same arrangements for directors apply. Registered 28th ult. by Fox and Thicknesse.

**Provincial Electric Light and Power Supply Company, Limited.**—Capital, £1,000 in £1 shares. Objects: To carry on electric lighting business in the provinces. Signatories as in five preceding companies. Registered 28th ult. by Fox and Thicknesse.

**New Cadogan and Belgrave Electric Supply Company, Limited.**—Capital £1,000, in £10 shares. Objects: To take over the business and undertaking of the Cadogan Electric Light Company, Limited. Signatories (with 1 share each): \*A. Greenwood, 8, Cavendish Road, Leeds; \*Lieut.-Col. A. W. Thynne, 50, Cadogan Square; J. S. Sayer (electrical engineer), 37, Drayton Gardens, South Kensington; G. Chapman, 48, Luiver Road, Fulham; G. Hogger, Hether Green, Lewisham; C. Bonsor, 8, Vincent Square, Westminster; A. S. Batley, Thames Ditton. The signatories denoted by an asterisk are the first directors; qualification, £100 in ordinary shares; the company in general meeting will determine remuneration. Registered 30th ult. by Brook, Freeman & Batley, 89 Chancery Lane.

**Weston-super-Mare Electricity Supply Company, Limited.**—Capital £100, in £1 shares. Objects: To carry on business as electricians and electrical engineers in all branches. Signatories (with 1 share each): H. G. Massingham, Bath Electric Light Works; Emile Gareke, J. C. Raworth, R. A. Dawburn, W. Geipel, W. M. Mordey, and R. Percy Sellon, all of 112, Belvedere Road, Lambeth. Most of the regulations of Table A of the Companies' Act, 1862, will regulate the affairs of

the company. Registered 30th ult. by Sydney Morse, 4, Fenchurch Avenue; office, 112, Belvedere Road.

**Bristol Electricity Supply Company, Limited.**—Capital, £100 in £1 shares. Objects: To carry on business as electricians in all branches. The signatories are the same as in the preceding company. Registered 30th ult. by Sydney Morse, 4, Fenchurch Avenue, E.C.

**Northern Counties Electric Light and Power Supply Company, Limited.**—Capital, £1,000 in £1 shares. Objects: To carry on in Northumberland and elsewhere the general business of an electric light company in all branches. Signatories (with 1 share each): Ralph Thicknesse, 11, Abchurch Lane; E. J. Jennings, 13, Victoria Street; E. W. Monkhouse, 3, Robertson Terrace, Hastings; F. B. Nicholson, 9, St. Petersburg Place, Bayswater; F. W. Stenlake, 13, Victoria Street; A. F. Barter, 60, Hercules Buildings, Lambeth; Wm. Jennings, 59, Fleet Street. The signatories are to appoint the first directors; qualification, £50 in shares or stock; remuneration, chairman, £200 per annum; each director, £100 per annum. Registered 30th ult. Solicitors, Messrs. Fox and Thicknesse, 11, Abchurch Lane.

**Paddington and Bayswater Electric Light and Power Supply Company, Limited.**—Capital, £1,000 in £1 shares. Objects: To carry on electric lighting in the parish of Paddington and elsewhere. Signatories (with 1 share each): F. B. Nicholson, 7, St. Petersburg Place, Bayswater; C. Jennings, Montpelier Road, S.E.; E. J. Jennings and F. A. Stenlake, 13, Victoria Street; C. Baizley and W. R. Adams, 59, Fleet Street. The arrangements for directors are the same as in the preceding company. Registered 30th ult. Solicitors, Fox and Thicknesse, 11, Abchurch Lane, E.C.

**District Messenger Service and News Company, Limited.**—Capital £200,000 in £5 shares. To manufacture and supply electrical appliances for transmitting messages, signals, and for other purposes, and to purchase certain letters patent upon terms of an unregistered agreement with Charles Tweed Russell. Signatories (with 1 share each): H. G. Asten, R. B. Smith, A. Lovis, 50, Lime Street; H. Osbornler, 24, Cedars Road, Clapham; G. Macmaldrew, 26, Woburn Place; C. Tweed Russell, 18, Southwell Gardens, South Kensington; W. H. Williams, 60, Felenstowe Road, Kensal Green. The signatories are to appoint the first directors; qualification, £500 in shares; remuneration, £250 per annum each, with £50 additional for the chairman. Registered 30th ult. by Ashurst, Morris, Crisp & Co., 6, Old Jewry.

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## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

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**British Electric Light Company, Limited.**—An agreement of 19th ult. between this company and John Muirhead and Latimer Clark, cites that the two latter are unsecured creditors of the company for £800, and have agreed to accept 40 fully paid preference shares in satisfaction thereof.

**Northern District Telephone Company, Limited.**—At an extraordinary meeting of this company, held at Oxford Court, Cannon Street, on the 15th May, special resolutions were passed approving an agreement for the sale of the business and property of the company to the National Telephone Company, Limited, and with a view to giving effect to the same to wind up voluntarily, Mr. Thomas Abercrombe Melton be appointed liquidator. The resolution was confirmed on the 12th ult., and was filed on the 28th ult.

**Northampton Electric Light and Power Company, Limited.**—The annual return of this company, made up to the 17th ult., was filed on the 24th ult. The nominal capital is £50,000, divided into 10 A and 49,990 B shares of £1 each. The whole of the former

and 10,000 of the latter are taken up. Upon the B shares the full amount has been called, the calls paid amounting to £4,927, and unpaid to £5,073.

**Electrical Engineering Corporation, Limited.**—At an extraordinary general meeting of this company, held at 3, Prince's Mansions, Victoria Street, on the 8th May, certain alterations were made in the articles of association, one of these fixing the qualification of a director at £500 in shares. The special resolutions were confirmed on the 6th June, and were duly filed on the 23rd June.

**General Electric Power and Traction Company, Limited.**—An agreement of 22nd May with the Electric Construction Corporation provides for the acquisition by this company of certain license of patents for £30,000 in fully paid ordinary shares.

**Railway Electrical Contractors, Limited (in Liquidation).**—The registered office of this company is now situate at 1 and 2, Great Winchester Street.

**City of Westminster Electrical Syndicate.**—The registered office of this company is situate at 4, Victoria Mansion, Victoria Street, Westminster.

**New Electric Fire Lighter Company, Limited.**—The registered office of this company is situate at the Works, Marsh Gate Lane, Stratford, E.

## LEGAL.

**Chatenay v. the Brazilian Submarine Telegraph Company.**—This case came before Mr. Justice Day, sitting without a jury, on Wednesday. The plaintiff, who resides at Rio, said he was, at the time of his mother's death, the registered holder of 50 shares in the defendant company, whose offices are in London, but since then his name had been removed from the register of shareholders without his consent, and some other person's name had been substituted as the holder of the said shares. The plaintiff had given a power of attorney to his agent, Mr. Bruyere, of London, to act for him, and the question his Lordship was asked to decide was whether Brazilian or English law governed this power of attorney.

Mr. H. D. Greene, Q.C., and Mr. Alexander Young were counsel for the plaintiff; Mr. R. B. Finlay, Q.C., Mr. Graham, and Mr. Calvert were counsel for the defendant.

Mr. GREENE said the defendant wanted to issue a commission to Brazil to take evidence as to the meaning of this alleged power of attorney, contending that Brazilian law would govern the operation of it in this country. Mr. Chatenay, in his deposition, said he had never received dividends on the shares direct, but through his agent in London. Plaintiff was trustee for other members of his family, and he had never authorised anyone to transfer these shares. The learned counsel submitted that under these circumstances Mr. Bruyere's rights under the power of attorney were regulated by English law.

Mr. FINLAY insisted that the document having been executed in Brazil by the plaintiff, a resident in Brazil, it must be governed by the Brazilian law.

His LORDSHIP, at the conclusion of the arguments, held that the power of attorney was a general power, and must be governed by the laws of the country in which it was exercised.

the company's revenue was secure. The amount brought forward last year amounted to £4,878 4s. 8d. as against £1,215 9s. 11d. in 1888, or an increase of £3,662 14s. 9d. The total expenses in 1889 were £21,155 9s. 8d., and in 1888 they were £20,016 0s. 7d., so that there was an increase of £1,139 9s. 1d., which was due almost entirely to the causes he had mentioned. The hire of cable repairing ships—viz., £1,780 3s. 1d., was charged to the current revenue account, and a balance of preliminary expenses, £750, was written off. A fair amount had been written off for depreciation of cable stock. The net result of 1888, after providing for expenses, interest, and a sinking fund for the redemption of 5 per cent. debentures, had been a dividend of 2½ per cent. per annum, £5,000 to repairs and renewals account, and £4,878 4s. 8d. carried forward. This time they declared a dividend of £5 per cent. for the year, and they charged repairs and renewals to the revenue account, and they carried to the general reserve fund the sum of £16,145 11s. The balance to the credit of repairs and renewals, £3,074 2s. 5d., has been carried to the general reserve fund, so that the interest on investments added to the general reserve fund amounted to £19,712 18s., fully invested. This, he thought, was a fulfilment of the promise made by him twelve months ago. In 1887 they had no dividend, in 1888 the dividend was 1½, in 1889, after the reconstruction of the Board, the dividend was 2½ per cent. He believed that the company was destined to play a very important part in the opening up of the "dark continent." Referring to the Telegraphic Conference lately held in Paris, he claimed that the result was on the whole that the cable companies held a higher position than probably they had ever done in the estimation of the public and continental governments. He admitted they were fairly treated on the whole, although the tendency was to reductions, in which they must bear their share, whilst they consoled themselves with the thought that reductions very often lead to increased traffic. He moved the adoption of the report and accounts, and the declaration of a dividend, payable on and after that date, of 6s. 6d. per share, free of income tax, making, with the interim dividend already paid, a total distribution for the year of 5 per cent.

The motion was carried unanimously, Sir John Pender and Mr. R. K. Gray were re-elected directors, the appointment of Mr. J. Denison Pender as a director was confirmed, and Messrs. Deloitte, Dever, Griffiths & Co. were reappointed auditors of the company, and with a vote of thanks to the chairman and directors the proceedings came to a close.

## The National Telephone Company, Limited.

THE report of the directors to be presented at the tenth ordinary general meeting, to be held at the Cannon Street Hotel on Friday, 11th July, at 12 o'clock, states:—The directors have the pleasure of submitting to the shareholders the accounts for the year ending 30th April, 1890, showing a balance to the credit of net revenue account of £183,375 19s. 7d., after providing for the amalgamation expenses, and the accrued interest on the debentures and new shares. Of this amount the sum of £66,131 5s. has been absorbed by the payment of an interim dividend on the preference and ordinary shares at the rate of 6 per cent. per annum for the first six months of the year. The directors propose to pay a further dividend on both classes of shares at the rate of 6 per cent. per annum for the last half of the year, which will absorb a further sum of £66,131 5s., and leave a balance still on hand of £51,113 9s. 7d. In view of the near expiration of the company's patents, the directors think it prudent to strengthen the reserve account, and they propose, under article 113 of the articles of association, to transfer to this account £40,000, leaving £11,113 9s. 7d. to be carried forward to next year. The extension of the company's business during the past year has been very satisfactory, the gross annual rental from exchange, trunk, and private lines having increased from £343,544 1s. 1d. on the 30th April, 1889 (prior to the amalgamation), to £392,541 19s. 1d. on the 30th April, 1890, an increase in the year of £48,997 18s. The important trunk lines connecting London with the principal towns in the Lancashire, Yorkshire, and Midland districts were completed as far as Edgware in January last, and the service proved to be perfectly clear and distinct. Some difficulty was then experienced in running the wires through to London, which was not overcome in time to have the connection completed before the issue of this report. The directors have every confidence that the communication between London and the North will be established by the end of this month. A large number of additional trunk lines connecting various towns in the provinces have also been commenced during the year, many of which have been completed. These trunk lines supply a much-felt public want, and will add greatly to the strength of the company. The directors believe it most important to continue the policy of developing and improving the company's system, and of giving greater facilities to the public. The capital required for this purpose the directors propose to raise by the issue of debenture stock or preference shares, as may be found best for the interests of the company. The accrued rental for the year ending 30th April, 1890, was £364,704 17s. 5d., an increase of £45,162 over the accrued rentals of the National, United and Lancashire and Cheshire Companies for the year before the amalgamation. The working expenses for the year ending 30th April, 1890, amount to £148,457 0s. 9d., being 40·7 per cent. on the accrued rental, whilst the working expenses of the three companies before the amalgamation were

## CITY NOTES, REPORTS, MEETINGS, &c.

### The West African Telegraph Company, Limited.

THE fifth ordinary general meeting of the shareholders was held at Winchester House on Thursday, the 3rd inst., to receive the directors' report and accounts, &c., for the year ending 31st December, 1889 (printed in our last issue).

Sir John Pender, K.C.M.G., who presided, said that several new stations for the company's joint working arrangements had been established in the year under review, and that a new cable had been laid between Bonny and Principé. As regards the net result of the year's working, compared with the previous year, the gross revenue amounted to £64,661, as against £55,315, or an increase of £9,346, almost entirely derived from the traffic with South Africa. Communication between the company's line and Cape Town was established on the 4th June last, so that they had only had the benefit of the new traffic for seven months. The South African traffic was worked under a joint purse agreement between the Eastern, the Eastern South African, the Brazilian Submarine, the Spanish National, and this company; and so long as communication was maintained by either coast

47·7 per cent. This saving of 7 per cent. is owing to reductions of working expenditure rendered possible by the amalgamation. The directors have taken over the business of the Northern District Telephone Company, Limited, which is now merged in this company. The Postmaster-General not having given notice to purchase the company's business under the power reserved by the terms of his licence, is not now entitled to do so for another period of seven years. The auditors, Messrs. Welton, Jones & Co., retire, and are eligible for re-election.

### The Electric Engineering Company of Ireland.

THE first statutory meeting of the Electric Engineering Company of Ireland was held last week in the board room, Dawson Street, Sir Howard Grubb, F.R.S., presiding. The company was registered on the 5th March, 1890. The prospectuses were issued to the public on the 8th, and 6,800 £2 shares were allotted to the public and vendors.

The Chairman said the company had obtained some good contracts, and the great number of estimates which they had been asked to furnish not only gave good promise for the future, but showed very clearly that the establishment of such a company was a necessity in Dublin. However, there were many causes to check its immediate development. The acceptance of many of the estimates applied for had been made contingent on the starting of the general electric lighting scheme proposed by the Corporation of Dublin, the arrangements for which were not quite complete, and the period within which it would be available for the general public was therefore uncertain. If no such scheme had been contemplated, many business houses would be prepared to erect private installations; but so long as the matter remained uncertain, they could not expect intending users to lay out money on private installations. Again, the public required to be further educated as to the advantage of electric lighting. Up to the present the question which users invariably asked was simply, Will my gas or my electric light bill be the heavier at the end of the year? But he thought the time was coming when in comparing the relative advantages of the systems the public will learn to place the doctors' bills, deterioration of furniture, decorations, books, &c., on the right side of the account, and perhaps by that time would be getting a little tired of the oft-repeated story of the electrically-frizzled horse. Perhaps he might be allowed to mention one specific case which had come under his own immediate ken. In an institution in which he frequently had business, he happened to know that a sum of £50 was added to the decorator's estimates for the purpose of doing some gilding to the ceiling and cornices of one particular room. Judging by the effect already produced, though the gas was seldom used in that room, this would not last for many years, whereas if electric light were in use it would be good for 50 years; also, he understood that a considerable sum of money would have shortly to be expended in the rebinding of books, the backs of which had been completely destroyed by the products of the gas. In this particular case it would certainly have been much cheaper to have used electric light than gas, even if the latter had been supplied without any charge whatever. Again, electric light installations had been frequently undertaken by firms wholly without the required technical knowledge or the means of obtaining it, result being that the work has been done in an inefficient manner. In this company there was no mixing up of electric light with any other business. They had an efficient staff of electric engineers, all of whom had held positions under some of the largest and best known electric light companies now working, in addition to which, in case of any work of great magnitude, they had the advantage of the experience of one of the oldest, largest, and most successful electric lighting companies in the world—viz., the Brush Corporation of London. The temptation in the case of inexperienced firms, particularly when there is much competition, was to promise too much, and to cut down the estimates as closely as possible to secure the order. Their board did not believe in the wisdom of endangering the future reputation of the company for the sake of a possibly increased show of work in the present; nor did they propose to undertake work (for advertising or other such purposes) which would not pay a reasonable profit. In conclusion, the chairman pointed out the advantages to health from the use of electric light instead of gas, and quoted from an article which appeared in the *Daily News*, and in which it was stated that since the installation of electric light in the Post Office, there had been a saving of £600 a year effected, owing to the decrease of leave of absence to the members of the staff who were ill.

Sir H. Grubb was re-elected chairman, and Messrs. George F. Fitzgerald, Thomas J. Haslam, Emile Garcke, David Sherlock, and J. H. North directors, and a sum of £200 per annum was agreed to be set apart as the remuneration for the directors other than the managing director.

Messrs. Harrison and Nichols were elected auditors to the company.

A Shareholder asked why the contract for the lighting of the New Science and Art Museum had not been obtained by the company?

The Chairman said the contract had been closed before the company was incorporated.

M. Emile Garcke, secretary of the Brush Electric Company, London, was moved to the second chair, and a vote of thanks was passed unanimously to Sir Howard Grubb for presiding.

Sir Howard Grubb having responded, the proceedings terminated.

### Maxim-Weston Electric Company, Limited.

A MEETING of the shareholders of this company was held at Winchester House, on Wednesday, to consider the present condition of the company. Our own reporter was refused admission, but we are enabled to give the following report:—

The Chairman (Mr. Gooding), after giving some facts as to the value of the stock, machinery and assets of the company, stated that there had been a great reduction in the working expenses. The directors had not taken, and did not intend to take, any fees pending the decision in Mr. Watt's action. In the past the electric lighting companies had paid enormous sums for patents which were of little value, and that had rendered difficult their successful development. The Maxim-Weston Company had several complete installations, and were supplying plant, &c., not only in this country, but in Ireland, and were continually receiving enquiries for tenders, but it was somewhat difficult to carry on negotiations because they were hampered for want of capital. The directors have shown great faith in the company and he hoped the shareholders would do the same, and find the necessary money to carry the company on successfully.

Mr. Hodgson (a new director), on being asked his opinion of the company, stated that since he had been on the board he had given a great deal of time and consideration to its affairs, and believed that, without any great outlay, they could carry out the electric lighting on a large scale very successful. He should have no hesitation in subscribing more capital.

Several shareholders, after a short discussion, expressed their willingness to contribute in the way of debentures.

The Chairman stated that he and the other directors were prepared to do likewise. The meeting was of an informal character and no resolution could be passed, but the directors and a number of shareholders having agreed to subscribe capital it would, he said, be done by way of floating debentures with security on the works of the company.

**The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.**—A half-yearly general meeting of the company will be held at the Cannon Street Hotel, London, on Thursday, the 10th inst., at 12 o'clock noon, for the purpose of obtaining the sanction of the shareholders to the payment of an interim dividend of 5 per cent., or 10s. per share, free of income tax. The company's share register will be closed till the 10th inst.

**The Eastern Extension, Australasia, and China Telegraph Company, Limited.**—This company notifies that the coupon on their 5 per cent. Australian Government subsidy debentures, due on July 1st, will be paid on and after that date, at the banking house of Messrs. Barclay, Bevan & Co., 54, Lombard Street, E.C. The directors have also declared an interim dividend of 2s. 6d. per share, tax free, payable on the 15th inst.

**The United Electrical Engineering Co., Limited, in Liquidation.**—By notice in the *Gazette*, June 27th, creditors of the company are required on or before July 26th, 1890, to send their names and addresses, particulars of their debts or claims, and the names and addresses of their solicitors (if any) to Alfred Sydney Gedge and William Leonard Madgen, the liquidators, No. 3, St. James Street, Bedford Row, Middlesex.

**The Automatic Electric Railway Signal Company, Limited.**—By an Order of the High Court, Chancery Division, dated 21st June last, on the petition of Blakey, Emmott and Co., Limited, of Square Road, Halifax, York, creditors of the company, it was ordered that the winding up of the company be continued, subject to the supervision of the Court.

**Western Counties and South Wales Telephone Company, Limited.**—At an extraordinary meeting of this company, held on Friday last, the resolution passed at the meeting of May 30th, for the alteration of the articles of association, was confirmed.

**The American Bell Telephone Company.**—The directors have declared an extra dividend of 6 per cent., in addition to the regular 3 per cent.

### TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company. The receipts for the month of June were £3,300, as compared with £3,337 in the corresponding month of last year. The receipts for the month of March, estimated at £4,000, realised £4,018.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of June were £2,085, against £1,600 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of June, 1890, amounted to £43,198, an increase of £3,848.

The Eastern Telegraph Company, Limited. The receipts for the month of June, 1890, amounted to £51,019, an increase of £6,214.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 27th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,216.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of June, 1890, were £5,475.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 30th June, are £3,127, an increase of £353.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (June 25).	Closing Quotation. (July 3.)	Business done during week ending July 3, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	99 — 102	97 — 100 xd	100	99 $\frac{3}{4}$
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	51	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	86 — 87	86 — 87	87	86 $\frac{1}{2}$
2,725,420	Do. do. Deferred	Stock	14 $\frac{1}{2}$ — 15 $\frac{1}{2}$	14 $\frac{1}{2}$ — 15	14 $\frac{1}{2}$	...
130,000	Brazilian Submarine Telegraph, Limited	10	11 $\frac{1}{2}$ — 12 $\frac{1}{2}$	11 $\frac{1}{2}$ — 12 xd	12	11 $\frac{1}{2}$
99,000	Do. do. 5 p. c. Bonds	100	101 — 103	101 — 103	...	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	106 — 109	103 — 107 xd	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2 $\frac{1}{2}$ — 2 $\frac{1}{2}$	2 $\frac{1}{2}$ — 2 $\frac{1}{2}$	2 $\frac{3}{8}$	2 $\frac{1}{8}$
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1 $\frac{1}{2}$ — 2	1 $\frac{1}{2}$ — 2	1 $\frac{1}{2}$	1 $\frac{1}{2}$
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	$\frac{1}{2}$ — $\frac{5}{8}$	$\frac{1}{2}$ — $\frac{5}{8}$	...	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	...	...
16,900	Cuba Telegraph, Limited	10	12 — 12 $\frac{1}{2}$	12 — 12 $\frac{1}{2}$	12 $\frac{1}{2}$	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited	5	3 $\frac{1}{2}$ — 4 $\frac{1}{2}$	3 — 4	3 $\frac{5}{16}$	3
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10 $\frac{1}{2}$ — 10 $\frac{3}{8}$	10 $\frac{1}{2}$ — 10 $\frac{3}{8}$	10 $\frac{3}{8}$	10 $\frac{5}{16}$
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14 $\frac{1}{2}$	14 — 14 $\frac{1}{2}$	14 $\frac{5}{16}$	14
70,000	Do. do. 6 p. c. Preference	10	15 — 15 $\frac{1}{2}$	15 — 15 $\frac{1}{2}$	15 $\frac{1}{2}$	15 $\frac{5}{16}$
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 — 111	108 — 111	...	...
1,250,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	108	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 $\frac{1}{2}$ — 14 $\frac{1}{2}$	14 $\frac{1}{2}$ — 14 $\frac{1}{2}$	14 $\frac{1}{2}$	14 $\frac{1}{2}$
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	101 — 103	101 — 103	...	...
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	104 — 107	103 — 106 xd	...	...
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	103 — 106 xd	104 $\frac{1}{2}$	...
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	102 — 105	100 — 103 xd	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4 $\frac{1}{2}$ — 5 $\frac{1}{2}$	4 $\frac{1}{2}$ — 5 $\frac{1}{2}$	...	...
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 $\frac{1}{2}$ — 6 $\frac{1}{2}$	5 $\frac{1}{2}$ — 6	5 $\frac{1}{2}$	5 $\frac{1}{16}$
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	5	2 $\frac{1}{2}$ — 2 $\frac{1}{2}$	2 — 2 $\frac{1}{2}$	...	...
180,227	Globe Telegraph and Trust, Limited	10	8 $\frac{1}{2}$ — 9 $\frac{1}{2}$	9 — 9 $\frac{1}{2}$	9 $\frac{1}{2}$	9
180,042	Do. do. 6 p. c. Preference	10	15 — 15 $\frac{1}{2}$	15 — 15 $\frac{1}{2}$	15 $\frac{1}{2}$	15
150,000	Great Northern Tel. Company of Copenhagen	10	15 $\frac{1}{2}$ — 16 $\frac{1}{2}$	15 $\frac{1}{2}$ — 16 $\frac{1}{2}$ xd	16 $\frac{1}{2}$	15 $\frac{1}{2}$
40,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	102 — 105	100 — 103 xd	...	...
250,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107	...	...
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	12 — 13	12 — 13	...	...
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 $\frac{1}{2}$ — 12 $\frac{1}{2}$	11 $\frac{1}{2}$ — 12 $\frac{1}{2}$	12 $\frac{1}{2}$	...
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	19 — 20	19 — 20	...	...
200,000	Do. do. 4 $\frac{1}{2}$ p. c. Deb., 1896	100	103 — 105	103 — 105	...	...
17,000	Indo-European Telegraph, Limited	25	37 — 39	37 — 39	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000	Do. do. do. 6 p. c. Debentures	100	107 — 110	107 — 110	108 $\frac{1}{2}$	108
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	4 $\frac{1}{2}$ — 5 $\frac{1}{2}$	5 $\frac{1}{2}$	5
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	5 $\frac{1}{2}$	5 $\frac{1}{2}$
49,825	Do. do. New Nos. 386,876 to 436,700	5	5 — 5 $\frac{1}{2}$	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	5 $\frac{1}{2}$	5 $\frac{1}{2}$
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 $\frac{1}{2}$ — 13	12 $\frac{1}{2}$ — 13	13	12 $\frac{1}{2}$
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 $\frac{1}{2}$ — 10 $\frac{1}{2}$	10 $\frac{1}{2}$ — 10 $\frac{1}{2}$	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	$\frac{1}{2}$ — $\frac{1}{2}$	$\frac{1}{2}$ — $\frac{1}{2}$	...	...
9,000	Reuter's, Limited	8	7 $\frac{1}{2}$ — 8 $\frac{1}{2}$	7 $\frac{1}{2}$ — 8 $\frac{1}{2}$	...	...
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	$\frac{1}{2}$ — ...	$\frac{1}{2}$ — ...	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3 $\frac{1}{2}$ only paid)	5	3 — 3 $\frac{1}{2}$	2 $\frac{1}{2}$ — 3 $\frac{1}{2}$	...	...
3,381	Submarine Cables Trust	Cert.	112 — 116	112 — 116	...	...
78,949	Swan United Electric Light, Limited (£3 $\frac{1}{2}$ only paid)	5	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	5 $\frac{1}{2}$ — 5 $\frac{1}{2}$	5 $\frac{9}{16}$	5 $\frac{1}{2}$
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45 $\frac{1}{2}$	...
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 — 104	100 — 102 xd	...	...
55,000	United River Plate Telephone, Limited	5	4 $\frac{1}{2}$ — 5	4 $\frac{1}{2}$ — 5	...	...
146,000	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94 xd	...	...
100,000	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	...	...
15,609	West African Telegraph, Limited, Nos. 7,591 to 23,109	10	9 $\frac{1}{2}$ — 10 $\frac{1}{2}$	9 $\frac{1}{2}$ — 10 $\frac{1}{2}$	10	...
300,000	Do. do. do. 5 p. c. Debentures	100	99 — 102	99 — 102	101	...
30,000	West Coast of America Telegraph, Limited	10	6 $\frac{1}{2}$ — 7	6 — 6 $\frac{1}{2}$	6 $\frac{1}{2}$	...
150,000	Do. do. do. 8 p. c. Debs. repay. 1902	100	111 — 116	108 — 112 xd	...	...
64,572	Western and Brazilian Telegraph, Limited	15	10 — 10 $\frac{1}{2}$	10 — 10 $\frac{1}{2}$	10 $\frac{1}{2}$	10
26,986	Do. do. do. 5 p. c. Cum. Preferred	7 $\frac{1}{2}$	6 $\frac{1}{2}$ — 7	6 $\frac{1}{2}$ — 7	6 $\frac{1}{2}$	6 $\frac{1}{2}$
26,986	Do. do. do. 5 p. c. Deferred	7 $\frac{1}{2}$	3 $\frac{1}{2}$ — 4	3 $\frac{1}{2}$ — 4	...	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	106 — 109	106 — 109	...	...
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 — 107	104 — 107	104 $\frac{1}{2}$	...
88,321	West India and Panama Telegraph, Limited	10	2 $\frac{1}{2}$ — 2 $\frac{1}{2}$	2 $\frac{1}{2}$ — 2 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{2}$
34,563	Do. do. do. 6 p. c. 1st Preference	10	11 — 11 $\frac{1}{2}$	11 — 11 $\frac{1}{2}$	11 $\frac{1}{2}$	11 $\frac{1}{2}$
4,669	Do. do. do. 6 p. c. 2nd Preference	10	12 $\frac{1}{2}$ — 13 $\frac{1}{2}$	12 $\frac{1}{2}$ — 13 $\frac{1}{2}$	12 $\frac{1}{2}$	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125	122	...
179,300	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 101	99 — 101	...	...
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1 $\frac{1}{2}$ — 2 $\frac{1}{2}$	1 $\frac{1}{2}$ — 2 $\frac{1}{2}$	...	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6 $\frac{1}{2}$  paid), 7 $\frac{1}{2}$ —7 $\frac{1}{2}$ .—Electric Construction Corporation (£10 paid), 9 $\frac{1}{2}$ —10 $\frac{1}{2}$ .  
 —House-to-House Company (£5 paid), 5—5 $\frac{1}{2}$ .—London Electric Supply Corporation, Ordinary (£5 paid), 2 $\frac{1}{2}$ —2 $\frac{1}{2}$ .—Manchester  
 Edison and Swan Company, £9, (£1 paid), 11/-—12/-.

THE LINEFF TRAMWAY MAGNETIC  
CONDUCTOR.

ALTHOUGH we have described the Lineff system in a previous issue, we have been requested to insert the following in our present issue:—

The new Lineff conductor for tramways is the first which has practically taken advantage of the force of magnetism, in closing the circuit in electric traction. The surface rails are laid in lengths of about 3 feet in a bed of asphalt, and as they are without any groove, and have their upper surface flush with the roadway, they cannot form any obstruction to traffic either along or across the track. In point of fact they are hardly to be distinguished from the roadway itself.

Each of these rails is bolted by means of brass bolts and distance pieces to a piece of tee iron of equal length, so placed as to have its base on the same level as that of the surface rails, at a distance from it of about a quarter of an inch. The tee iron being of lower height than the surface rail does not appear at all on the roadway, being completely buried in the asphalt surrounding the whole. One end of the tee iron projects beyond the corresponding end of the surface rail, so that the rails when laid in position break joint with one another all along the road.

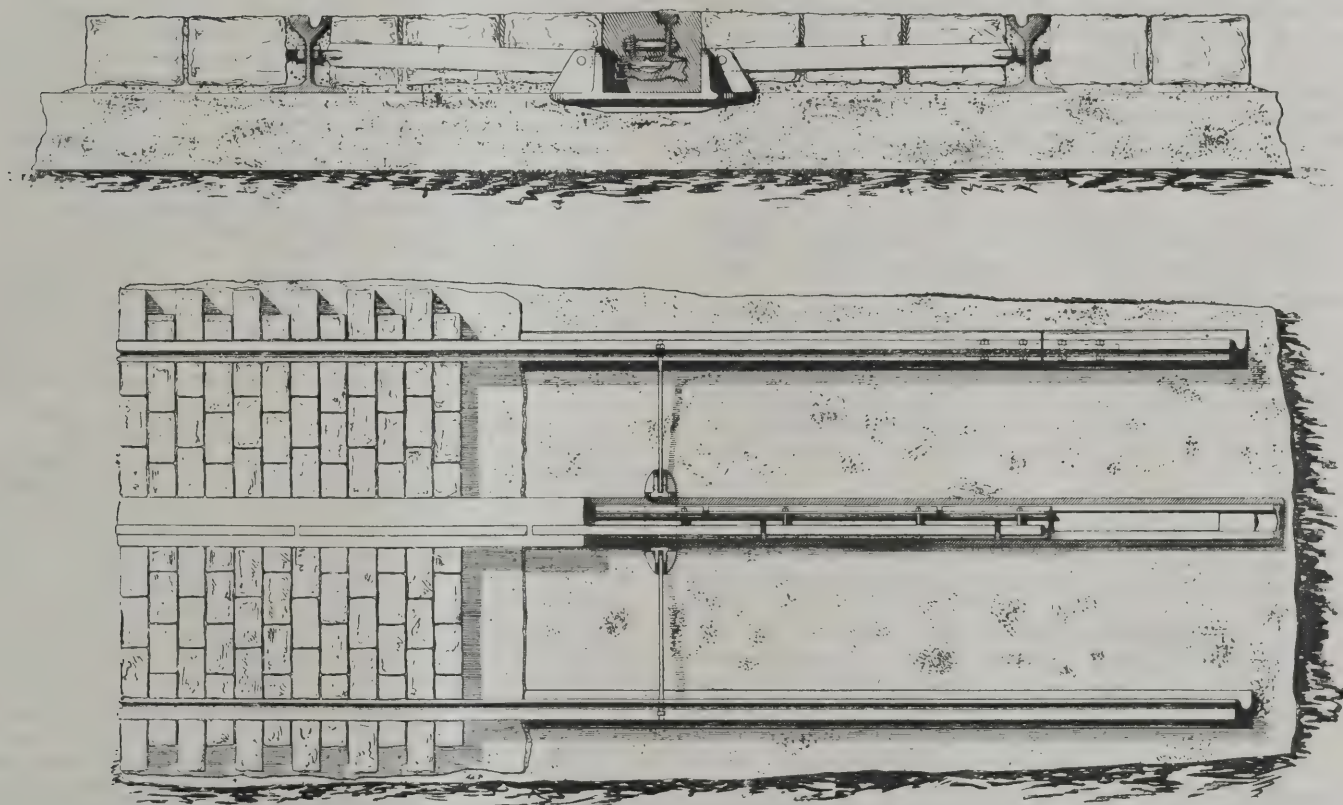
The two irons together form a roof to a continuous channel  $3\frac{1}{2}$

## ROYAL AGRICULTURAL SHOW.

THE annual show of the Royal Agricultural Society of England was held at Plymouth from the 21st to 27th June. In the machinery department were a number of exhibits possessing considerable interest as illustrating the increasing attention given by makers of engines and electrical machinery to the special requirements of country houses and large farms. Amongst them the premier place must be assigned to the joint exhibit of the *Priestman* oil engine and *Mr. Newton's* collection of machinery and apparatus for electric lighting and transmission of power, including the "Taunton" dynamo. The stand itself was ornamented with art drapery, and fitted up with a variety of lamps and shades. It attracted crowds of investigators, many of

## MAGNETIC CONDUCTOR FOR TRAMWAYS : LINEFF'S PATENT.

## CENTRAL ARRANGEMENT.



inches wide, formed by insulating tiles, on which the irons rest. This channel contains the bare copper main, shown in the drawing as a flat strip, and on this rests a flexible hoop iron 3 inches wide, which is free to rise into contact with the lower flanges of the surface and tee rails, from which it is in its normal position distant about  $\frac{5}{16}$ th inch.

Each car carries underneath it an electro-magnet, each pole of which contains a solid iron wheel which runs on the surface rail. The distance between the pole pieces is slightly greater than the length of one section of the surface rail, so that the two poles are never on the same section.

The magnet is energised by the main current, the wire forming the coils being coupled in shunt with the motor circuit.

The magnetic lines emanating from the magnet poles pass into the surface rail. The section of this being insufficient to carry the whole of the magnetic lines, a large proportion of them leak across to the buried tee rails, and as the connection between each pair of rails (surface and buried) is of a non-magnetic material, the lines jump across the air space between the lower flanges. Opposite poles are consequently induced in each of the surface and tee rails under the immediate influence of the electro-magnet, and the leakage "cross" lines, being diverted through the strip of hoop iron lying immediately below the air gap, in their attempt to shorten themselves attract the hoop iron into contact with the bases of the surface and tee rails; both of which, as they are in electrical (though not in magnetic) connection assist in taking off the current.

whom made on this occasion their first acquaintance with the electric light and the method of its production. Everything was open to inspection, and from an educational point of view the exhibit was a most useful one. The oil engine run by Messrs. Priestman Brothers was a 2 H.P. horizontal, and the "Taunton" dynamo was a 30-lighter, a set of accumulators being also employed in order to illustrate their use. A portable oil engine, 11 H.P., mounted on wheels, with shafts, was also shown driving a thrashing machine, and convincing the spectators of its suitability for such purposes. Messrs. Priestman Brothers have been awarded the first prize at this show for a small farmer's motor, and we are glad to hear that they are busy with orders in hand for home and abroad for their oil engines which are rapidly coming to the front as a motive power. According to the catalogue there should have been exhibited at one of the stalls a self-regulating dynamo, 5 unit, suitable for transmitting power to a motor for driving dairy and other machinery on a

farm, as well as two electric motors suitable for driving farm machinery, made by *Mr. J. E. Veale, of St. Austell's*, but in reality only the dynamo was on view, and that not working. At the stand of *Messrs. Gilbert Gilkes & Co.*, amongst other turbines, one was shown operating a small Gülicher dynamo. Amongst the "new implements" a magnetic separator and dynamo was exhibited by *Mr. J. Harrison Carter*, intended to surmount the serious obstacles attending the use of old toothed bone mills or disintegrators arising from the frequent presence of iron with the bone.

*Messrs. John Fowler & Co., Leeds*, exhibited what they have named the "Yorkshire" engine, horizontal, compound, 12 H.P., fitted with automatic expansion gear on both cylinders controlled by one governor, and specially constructed for driving dynamos or other machinery requiring steady driving. Another engine specially constructed for the same purpose, and shown by *Messrs. Ransomes, Sims and Jefferies*, was a 10 H.P. compound "Undertype" with patent automatic expansion gear. At *Messrs. Robey & Co.'s* stand was a vertical high speed engine, with cylinder  $6\frac{1}{2}$  inches diameter by 6 inches stroke, working at a pressure of 80 lbs., a very suitable engine for small electric light installations or for ship lighting.

*Messrs. Davey, Paxman & Co., of Colchester*, exhibited an improved compound portable steam engine and an improved single-cylinder portable steam engine, both of which were selected by the jurors for driving the various machines sent for competition. This we consider a great compliment to the makers. The steady running of these engines leaves nothing to be desired. The makers have maintained for very many years (in spite of much opposition), that first rate results can be obtained with compound engines working without condensers, and the performance of the one at present under consideration fully establishes all their arguments in favour of this class of engine.

The boiler is of the locomotive type with an improved firebox. The engine is complete in itself, being built on a steel channel frame which is securely bolted to brackets on the boiler. By merely removing a few bolts the whole engine and frame can be lifted from the boiler, and if so desired, fixed and worked separately.

Both engines are fitted with the Paxman automatic gear which has gained a world-wide character by the way in which it controlled the engines used for electric lighting at the various exhibitions, and especially in Paris.

The compound engine works at a pressure of 140 lbs. and the nominal horse-power is 8 H.P. The high pressure cylinder is  $5\frac{1}{2}$  inches in diameter, and the low one 9 inches. These sizes are such that the powers developed by the cylinders, separately, are about equal when working with a fair load. The stroke is 14 inches.

The other portable engine exhibited by this firm, viz., the single cylinder one, is of a different pattern. The cylinder is bolted on to the firebox, and the crankshaft is supported by two brackets bolted to the barrel of the boiler. The barrel of the boiler is lagged and the cylinder steam-jacketed. This engine is nominally of 8 H.P. but it will work up to 20 H.P., the diameter of the cylinder being  $9\frac{1}{2}$  inches and the stroke 12 inches. Both these engines are mounted upon wrought iron carriages and supported by wrought iron wheels of a simple and very strong design. They consist of a number of spokes of wedge shaped loops of iron, the free ends of which are cast into the centre, the sides of which are rivetted together. A wrought iron rim is shrunk on and rivetted to the outside of the loops.

The Knight paraffin oil engine, shown for the first time at the Windsor show last year, was exhibited this year by the makers, *Messrs. Brown & May*, who call attention to the fact that this engine works without electricity, and as only one kind of oil is used for starting and working, the cost and trouble is reduced to a minimum. It is said to be well adapted for driving electric light machinery, especially where the saving of space is important. The Forward gas engine was also

on the ground, as well as the new gas engine (Fielding's patent), lately introduced by the makers, *Messrs. Fielding & Platt*. The special feature of this engine is said to be its simplicity, as it has fewer working parts than any other in the market. Its working is silent and regular and the wear and tear very slight.

## COUNTY COUNCIL AND ELECTRIC LIGHTING.

### NUMEROUS EXTENSIONS SANCTIONED.

#### LONDON ELECTRIC SUPPLY CORPORATION.

At the weekly meeting of the London County Council on Tuesday last week, in the County Hall, Spring Gardens (the Earl of Rosebery in the chair), Mr. T. B. Westacott, the Chairman of the Highways Committee, submitted a report recommending the council to sanction the laying of mains by several electric lighting companies. The various recommendations were approved without discussion. The committee reported that they had "considered a notice (Registered No. 90) from the London Electric Supply Corporation, dated 4th June, 1890, of intention to lay trunk mains from Cockspur Street through the Haymarket, Glasshouse Street, Vigo Street, Burlington Gardens, Cork Street, Clifford Street, and Bond Street, to the company's station at the Grosvenor Gallery, as shown upon a plan submitted with the notice. In some of these streets the St. James's and Pall Mall Electric Lighting Company has already laid low-tension mains, and it appears to your committee advisable that the proposed trunk mains of the London Company should be laid beneath these. There seems to be no objection to the works, provided that proper means are taken for the protection of the mains; and your committee recommend—'That the sanction of the council be given to the works referred to in the notice (Registered No. 90), dated 4th June, 1890, of the London Electric Supply Corporation, on condition that in the streets where the St. James and Pall Mall Electric Lighting Company has already laid mains, the trunk mains referred to in the notice be laid beneath them; that the mains be protected from external injury by a sufficient outer covering, to the satisfaction of the council's engineer; and that the company do give three days' notice to him before commencing the works in any of the thoroughfares referred to in the notice.'"

A further notice (No. 91) of the same company to lay trunk mains in a part of Snow Fields, Bermondsey, was conditionally sanctioned.

The committee also reported:—"The company has given a further notice (Registered No. 92), dated 11th June, 1890, with one plan, of its intention to lay trunk mains in Newcomen Street, Union Street, Charlotte Street, Blackfriars Road and Cross Street; and the company asks that this may be substituted for the notice (Registered No. 61), dated 18th April, 1890, with reference to trunk mains across Borough High Street and Blackfriars Road, and through Southwark Street and Stamford Street, to which the council gave its sanction on 6th May last, at the same time requiring that the mains in Southwark Street should be laid in the subway there. It does not appear to your committee desirable that the council should interfere with the discretion of the company as to the route to be adopted for its trunk mains; but they are of opinion that the company may reasonably be required to lay its distributing mains at the same time as the trunk mains, in order to avoid a second interference with the same streets. Your committee, having given careful consideration to the matter, recommend—'That the sanction of the council be given to the works referred to in the notice (Registered No. 92) of the London Electric Supply Corporation, dated 11th June, 1890, on condition that the distributing mains be laid at the same time as the trunk mains in order to avoid a second interference with the same streets, and subject also to the same conditions regarding protection of the mains and notice of commencement of works as in the case of the two preceding notices.'"

#### WESTMINSTER ELECTRIC SUPPLY CORPORATION.

The committee's report as to this company was as under:—"The Westminster Electric Supply Corporation has given a notice (Registered No. 94), dated June 9th, 1890, with one plan, of its intention to lay mains in the following streets, viz.:—Park Lane, Hamilton Place, Hereford Gardens, North Row (part of), Green Street, Upper Brook Street, Upper Grosvenor Street, Mount Street, Tilney Street, Great Stanhope Street, Park Street, North and South Audley Streets, Grosvenor Square and Street, George Street (Oxford Street), Hart Street, Duke Street, Robert Street, Brook Street, Oxford Street (part of), South Molton Lane (part of), Hertford Street, Brick Street, Piccadilly, Hyde Park Corner, Down Street, Curzon Street, Chapel Street West, Queen Street, Carlos Street, Union Street (part of), Bolton Street and Row, Clarges Street (part of), Half Moon Street, Stratton Street, Berkeley Square and Street, Davies Street, Hay Hill, Bruton Street, Dover Street, Grafton Street, Arlington Street, Park Place, St. James's Street, Bennett Street, Albemarle Street, Old and New Bond Streets, Tenterden Street, Hanover Square and Street, George Street (Hanover Square), Maddox Street, Conduit Street, Prince's Street, Harewood Place, Swallow Place, Hill

Street and Stafford Street. These works are similar to those of the same company which have already been sanctioned by the council; and your committee recommend—"That the sanction of the council be given to the works referred to in the notice (Registered No. 94), dated June 9th, 1890, of the Westminster Electric Supply Corporation, on condition that the company do give three days' notice to the council's engineer before commencing the works in any thoroughfare; that the mains be laid under the footways wherever it is found practicable to do so; that the York stone covering for culverts under 20 inches wide be not less than 2 inches thick, and for wider culverts 2½ inches; and that where it is found necessary to lay the culverts under the carriage ways there shall be not less than 9 inches of Portland cement concrete between the cover stones of the culverts and the under side of the paving."

This recommendation was also approved, as were two others, sanctioning the laying of mains in Kensington Park Road, Victoria Gardens, Ladbroke Grove, and Horbury Crescent by the Notting Hill Electric Lighting Company; and in Brompton Road (part of), Ovington Square, and across Fulham Road by the Chelsea Electricity Supply Company.

#### THE SUBWAYS AND OVERHEAD WIRES BILL.

Mr. Charles Harrison, the Chairman of the Parliamentary Committee, submitted a long report respecting the London Subways and Overhead Wires Bill, and after some remarks as to the preamble and the opposition to the Bill when in committee, proceeded as follows:—"The Committee of the House decided to adopt the scheme of the report of 1885, and, in consequence, has conferred on all the local authorities, including the Commissioners of Sewers of the City of London, the duty of administering in their respective districts the bye-laws to be framed by the council. The Bill, as amended, provides that the council may, from time to time, make and vary bye-laws and regulations with respect to any of the following matters—The position and manner in which wires shall be placed in subways; the manner in which any repairs or alterations in any such wires may be made; the control and regulation of persons resorting to any such subway, and all persons fixing or altering any wire therein; the preparation, deposit, and correction of particulars of wires; the identification of overhead wires by registration or otherwise; the regulation of wires; the strength of the materials to be employed in placing, maintaining, and supporting wires; and the removal of wires erected or placed otherwise than in accordance with such bye-laws and of disused wires. These bye-laws are to be enforced by the local authority, except in so far as they may relate to any subway of the council, in which case they are to be enforced and administered by the council. Power is also given to the council (by obtaining an order of the Board of Trade) to enforce the bye-laws, in case of inadequate enforcement of them, or want of uniformity in the method of administering them, by the local authorities."

#### ELECTRIC LIGHTING ORDERS.

The committee further reported:—"It has been intimated by the Board of Trade that the following electric lighting orders will not be proceeded with:—Metropolitan Electric Supply Company, Limited (City of London); London Electric Supply Corporation Electric Lighting (City) Order; Fulham and Hammer-smith (House-to-House) Electric Supply Order; Paddington Electric Supply Order."

"On the 3rd instant we were authorised by the Council to present a petition against any electric lighting order in any confirming Bill which does not in effect comply with the council's resolutions of the 28th January and 22nd April, 1890. The solicitor has drawn our attention to the Electric Lighting Provisional Order Confirmation Bill, No. 9, which contains the five following provisional orders:—Lambeth Electric Supply Order; North London Electric Supply Order; St. James's Electric Lighting Order; London Electric Supply Corporation Electric Lighting (Metropolitan) Order; and Wandsworth District Electric Supply Order. We are advised that it is unnecessary to present a petition against any of these orders in the House of Commons, and we propose to reserve opposition, should it become necessary, for the House of Lords."

### GENERATION, DISTRIBUTION AND MEASUREMENT OF ELECTRICITY FOR LIGHT AND POWER, APPLIANCES THEREFOR, AND PARTICULARS OF CANADIAN INSTALLATIONS.\*

By A. J. LAWSON, M. Can. Soc. C.E., A.I.E.E., A.M.A.I.E.E.

Concluded from Vol. 26, p. 736.

#### The Royal Electric Company's Dynamo.

Sometimes the machines of the Royal Electric Company for A. C. work are made with the exciter on the same shaft, but more frequently the exciter is separate. In the 1,200-light dynamo with separate exciter, the active iron in the fields weighs about

\* Abstract of paper read May 8th, 1890, before the Canadian Society of the Civil Engineers.

3,400 lbs., and the iron rings of the armature (which is a hollow cylinder built up of laminated wrought iron) weigh 1,250 lbs. The radial depth of these rings is 5-inch. When turned up ready for winding the armature is 24½-inch diameter and 18½-inch long. The diameter when wound is 25½-inch over the bands, and, as the internal diameter of the field bobbins is 25½-inch, there is a clearance of full ⅜-inch all round. The fields are wound with 845 lbs. of No. 8 B. & S. gauge wire; the armature winding consists of 32 lbs. of No. 11 B. and S. gauge wire. The speed of the machine is 1,200 revolutions per minute, and the exciting current at full load is 24 ampères and 90 volts—say, 2,160 watts, or nearly 3 E.H.P. The standard output of the machine is 70 ampères and 1,020 volts, or 7·5 watts per lb. gross weight: 81·41 watts per lb. of the total copper wire, and 2,231 watts per lb. of the wire on the armature.

#### RATE OF ALTERNATION OR PERIODICITY.

In the Brush dynamo the periodicity is 110, while in the Fort Wayne, Westinghouse and Thomson-Houston machines the periodicity is from 125 to 136.

The European practice as to the rate shows considerable variation. Messrs. Ganz & Co., of Buda Pesth, in the Zipernowsky system use 42 cycles; Mr. Ferranti uses 68; Lowrie-Parker work their machines at 80, and Mr. Mordey runs his at 100.

#### CONVERTERS.

##### Westinghouse Converter.

The Westinghouse converter is of the shell type. In the 40-light converter, the core is built up of plates 0·17-inch thick, of which the total weight is 81 lbs. The primary winding of No. 16 wire weighs 10½ lbs., and the secondary wire is No. 3 gauge, 13½ lbs. in weight. At 50 volts and 40 ampères this converter gives an output of 19·09 watts per lb. of active material. The P.D. required between primary terminals is 1,000 volts, developing an E.M.F. of 50 volts at the terminals of the secondary coil.

Recent tests by Dr. Louis Duncan, of John Hopkins University, show 95 per cent. efficiency in a 40-light converter at full load, and only 84 watts loss with no load, and 90, 87·6, 83·3, and 70·7 per cent. efficiency in a 20-light converter at full, three-quarter, half and quarter loads respectively.

##### Brush Converter.

The Brush converters are of the core pattern, with the exception of the two of smallest size. The iron wire in the core of the 50-light converter weighs 92 lbs., the primary wire weighs 20 lbs., and the secondary winding 11 lbs. At 100 volts and 30 ampères its output is thus 24·39 watts per lb. of active material. The case weighs 100 lbs. The 75-light converter core of iron wire weighs 115 lbs., primary winding of copper wire 21 lbs., and secondary winding 15 lbs. At 100 volts and 45 ampères the output is 29·8 watts per lb. of active material. The case weighs 110 lbs. These converters are made in standard sizes of 5, 10, 20, 30, 40, 50, 75, 125, 250 lights, and up to 1,000 lights capacity. They are also made for primary circuits of 1,000 volts pressure, with a ratio of conversion of 10 to 1 or 20 to 1. The core consists of the finest Swedish iron wire, insulated by cotton winding or braiding wound into an octagon form, by having pieces of wood placed under and through the coils, as shown. The secondary wires are then wound over the sections between the wood blocks with insulated pads between them and the iron wire at the corners. Over the corners of the secondary winding are placed other insulating pads, over which are then wound the fine primary wires. There is thus an air space for insulation all round the different coils, except at the corners where the wires lie on the insulating pads. The efficiency of a 75-light converter varies from 98 per cent., with 75 lights attached, to 93 per cent., with 38 lights.

#### THOMSON CONVERTER.

The Thomson converter, manufactured by the Royal Electric Company in this city, is similar in construction to the Westinghouse. The following are the particulars of the 30-light size:—Iron discs, 108 lbs.; primary wire, 920 feet No. 18 B. & S. gauge, 4½ lbs.; secondary wire, 44 feet No. 8 B. & S. gauge, two in parallel, 4 lbs.; total active material, 116½ lbs., with an output of 13·20 watts per lb.; case, 59½ lbs.; weight complete, 176 lbs.

#### METERS.

##### Edison Meter.

In the Edison system of distribution an electrolytic meter has been employed. A disadvantage connected with its use is that nobody except an employé of the company can find out what the meter has registered, and even he has to take every precaution in the washing and drying of the electrodes, and in their accurate weighing in a chemical balance. This meter has been very extensively used, and has evidently given fair satisfaction, but statements from some of the superintendents of Edison stations show satisfaction is not general.

Sir D. Salomons, in the last edition of his work on electric lighting, describes the Edison meter as a thing of the past.

It is but fair to the Edison Company to say that they do not recommend their meters being used in stations of less than 1,000 lights capacity.

##### Aron Meter.

The Aron three-wire meter is used in all the large Edison stations, and by some other companies in Germany. It is a most admirable and reliable instrument, and it is one from which the

consumer himself can learn what he is using. The registering apparatus consists of two sets of clockwork, which will run 40 days with one winding, but which it is intended to wind up every 30 days, when the readings are taken. The pendulum on the left is an ordinary pendulum, uninfluenced by the current; but that on the right consists of a coil of very fine wire, which is connected direct to both the positive and negative wires of the system, while one of the main wires, either the positive or negative, forms a solenoid through which the main current passes, enveloping the fine wire pendulum core.

Before any current is passed through the meter, it should be tested in place to see that the pendulums swing synchronously. If they do not, the indications of one pendulum will gain upon those of the other. The exact adjustment to perfect synchronism is obtained by raising or lowering the weight on the left hand pendulum. If found correct the current is passed through the meter, and the right hand pendulum's movement being accelerated by the action of the current, causes the registering gear to work.

The chief obstacle in the way of the more general employment of this meter is its comparatively high first cost, but it appears to be well worth the money.

#### Shallenberger Meter.

The Shallenberger meter is the one which has been most extensively used in America for the measurement of alternating currents, having been exclusively used in the Westinghouse stations, and being now largely used in those of other companies. About 12,000 are now in use. It is simply a small alternating current motor with registering gearing, and attached vanes placed on the shaft to retard the movement to a degree necessary for adjustment and regulation. Its chief disadvantage is that it does not work readily with a small current, but as this tells against the company and not against the consumer, the latter will probably not have any objection to it.

#### STORAGE BATTERIES.

Storage batteries have not been applied on this continent to any such extent as they have been in Europe. Wherever they are employed, except for propulsion of about a dozen street railway cars, perhaps fewer, it has been for the purpose of securing light after engines and dynamos have been stopped at night, and for railway car lighting. For the latter purpose they have not hitherto been a success, and have been discontinued on the Pennsylvania Road, on the Canadian Atlantic, and on the Grand Trunk Railways, the Julien battery having been used in these cases. On the Intercolonial Railway a great number of cars have been fitted up with these batteries, and it is said several additional charging stations are to be erected, it having been found that the two at present in operation, one at Levis and the other at Moncton, together with such current as may be obtained at Halifax, N.S., and Montreal, have been insufficient, or otherwise expressed, the capacity of the batteries supplied has not been enough to last during the runs between the various stations. The fact that the coal oil lamps, which were wisely left in position, are used on nearly every trip, proves the inadequateness of the batteries which have been supplied for this work.

Outside of these plants storage batteries have been used in five or six places in Canada, among which may be mentioned McGill College, the lights which we have here being run from a Gibson battery in the basement. The battery is charged from a small shunt wound dynamo, driven by an Otto gas engine made by Crossley Bros., of Manchester.

#### VALLEYFIELD AND BARRIE CENTRAL STATIONS.

Let us describe briefly and compare these central stations, both constructed by the writer, and good samples of their respective classes. Both have water power, but the first is on the Edison three wire system, and the second is a Brush A. C. plant. In Valleyfield the power is in the heart of the town and in the centre of distribution, so that it is in the most favourable position for economical distribution by low tension, and the wire used is as small in area as consistent with even voltage at the lamps and best efficiency of the plant. Both stations were built with rooms for the man in charge over the dynamo room. The running expenses are the same or about the same in both places. Probably no other stations of similar capacity in the world cost less to run, the total annual expense in each being less than \$1,600. The capacity of both stations is about the same, say 60,000 watts. The Valleyfield station complete cost \$40,000, including building, water-wheels and flume. The Barrie station, with the same items, cost less than \$22,000, including over \$3,000 for the wire leading into town from the station, five miles distant. In the Barrie plant heavily insulated wire is used throughout the 24 miles of street wiring, and rubber covered wire in all buildings, whereas bare wire is used at Valleyfield for street wiring, and fire and weatherproof wire for inside work. House wiring in Valleyfield is all cleat work; most of that at Barrie is concealed, the lights in the latter place being principally in private houses, and placed on brass fixtures, whilst at Valleyfield drop cords are used exclusively. The pressure in the houses in Valleyfield is generally 220 volts, the three wires being carried in in all cases where this system is used, in order to maintain as even a load as possible on both sides of the circuit. In Barrie the pressure is 93 volts on the lamps in the houses, and nothing higher than 98 volts can ever enter them. The charge for current averages at Valleyfield \$9 per light a year, and at Barrie \$7.50. This means that, making due allowance for all contingencies in both cases, the Barrie plant will pay its shareholders better than the Valley-

field plant will, while the customers pay \$1.50 per light a year less. In the Barrie station Westinghouse meters are used on the premises of the largest consumers, and these can be read by the consumer as well as the meter man, the cost of operating the station is not increased, the man who attends to the wiring of the buildings in town and to collection of accounts taking the readings; while, if the Edison meter be used at Valleyfield, another man will require to be employed to attend to the meters solely, and his wages will have to be added to the operating expense and thus reduce the net revenue.

The respective sizes of wire used in both stations is worthy of study. At Barrie the loss in the feeder is 14½ per cent. at full load, nearly the same as at Valleyfield. The length of feeder at Barrie is 10 miles for the complete circuit, and the size of wire No. 4 B.W.G. At Valleyfield the feeders are three in number and three in a set; the longest is less than two miles for the complete circuit, and the size of the outside wires No. 000 B.W.G. The No. 4 wire used at Barrie weighs 985 lbs. per mile, including insulation, and the No. 000 bare wire at Valleyfield weighs 2,886 lbs. per mile.

It may be and has been said that in the one case you have a perfectly safe low tension system, while in the other, to use the pet phrase of the paid advocate of low tension, the New York State electric executioner, you have the "deadly alternating current." That is admirable as a trade trick, but even the Edison Company now advertise that they are prepared to supply A. C. plant to all who desire it. Either there is less danger in the A. C. system than they would have the public believe, or they are ready to subordinate principle to pocket in the contest. To alter slightly a phrase from Dickens's "Holiday Romance," the Edison people have been advising the public to "prohibit the use of the alternating current system on the ground of humanity, as it makes ours too expensive." In an article on the subject, Sir William Thomson, the greatest living authority on electrical matters, says:—

*"In passing, I may remark that 100 volts in the house is perfectly safe to the user, whether the current be alternating or continuous, as is proved by large and varied experience in England."*

It must be freely admitted that the accidents reported from New York were real and not invented for sensational purposes, but it must also be acknowledged that in no other city in the world is there such an organisation as the Board of Electrical Control, to which appointments are made by political influence only, regardless of qualification, and one of whose advisers is, or was, an individual whose business it was for the past two years to discredit the alternating system, for which service he was well paid. In no other city in the States or Canada is there such bad construction of overhead conductors as there was in New York, and the underground construction there is nearly as dangerous on account of existing grounds on the wires and leakage of current, and the consequent liability to cause explosions of gas in subways, as has already been repeatedly done, besides turning the paving stones into "a molten mass."

Furthermore, the insulation of the overhead wires, which have been in use in some cases over eight years, had rotted off, being of the quality known as "Underwriters," or "Undertakers," if you will.

Four deaths have occurred in the whole history of electric lighting in Canada from shocks of electricity, and two of these were the result of bad insulation of wires and faulty construction by a purchasing company doing its own work, without employing anybody having any knowledge of the business, in order to cheapen the first cost of the plant, and which purchased a job lot of poorly insulated wire, and ran two dynamos in series with 100 arc lamps in circuit at a tension of nearly 5,000 volts. The current used on that system was a continuous one, not a pulsating high tension current, as stated in a circular which some of you may have received.

Reverting to our main subject. Thirty wires radiate from the Valley field station; one pair carry the current from the Barrie station. In the Barrie station the pressure of primary current is the highest which has yet been used in this country, being about 2,100 volts average on the feeder. This pressure is raised or lowered by increasing or decreasing the exciting current according to the load shown on the central station ammeter, which is graduated to single amperes, and is indicated by a Cardew voltmeter, which, as elsewhere mentioned, is attached through a converter to the armature. Instead of having a compensator, as is used in the Westinghouse system, a table of loads and the corresponding pressures to be carried at the station is used. This method, though of course not absolutely perfect, owing to the rise of current with increase of voltage and *vice versa*, answers very well. The Cardew voltmeter in the company's office in town, which is an excellent check upon the dynamo attendant's work, shows an average variation of two volts only in a night's run. The mains in town, which aggregate nearly 14 miles in length, are calculated for a loss of only 2 per cent. at full load, which gives a difference of two-thirds of a volt per lamp up or down from the standard. The house wires, which are insulated with rubber and tape, are calculated for 1 per cent. loss only at full load. As most of the lights are taken in private residences, where the whole number are hardly if ever in use at one time, the loss of light through resistance of the house wiring is practically nil.

#### MEASURING INSTRUMENTS.

The Ayrton and Perry instruments have been used to a very considerable extent in this country, and until recently were the most accurate of all really portable electrical measuring instru-

ments. There is a sample on the table before you. They are only suited for direct currents, and are open to the objection that they have considerable friction and a high temperature error if kept in circuit, which they should never be except only for a few seconds when taking readings.

The Weston voltmeter has the great advantage of extreme accuracy and very high resistance, averaging about 20,000 ohms, so that the quantity of current passing is extremely small. They may be kept continuously in circuit without any material variation in their readings. They require careful handling, of course, as do all electrical instruments, but they are the most accurate and reliable of all portable testing instruments for continuous currents. The voltmeters contain a calibrating coil by which their constancy can be at all times tested. The writer has used quite a number of these instruments, which he has checked with each other, and has sometimes compared the higher and lower scale by taking the P.D. difference between terminals of single cells of secondary batteries, and then, putting the whole of the cells in series, compared the reading of total E.M.F. of the battery. Several tests of this nature have come out within one quarter of a volt. The calibrations are in single volts on the higher scale, and thirtieths, twentieths, or tenths of volts on the lower scale. The ammeters read to tenths of amperes in the small sizes. In both the divisions of the scale are so wide that one-quarter of these values can be read with perfect ease.

For the most perfect readings by these instruments they should be set quite level, and five feet away from any other instrument, or from any mass of iron or steel, and so placed that the index will point due west when at the centre of the scale, but these precautions are not necessary for ordinary testing of pressure in buildings, as the error can seldom be more than half volt if otherwise placed.

The Cardew voltmeter is used for both direct and alternating currents, and is made to be used either vertically or horizontally.

The horizontal pattern has the advantage of being steadier than the vertical instrument, owing to the disturbance caused by currents of air passing up the tube of the latter. All the more recent forms of this instrument have an adjusting screw outside of the case to bring the needle to zero, which should be done before the current is turned on. No adjustment should be made while the wire remains warm, as the section of the wire may be altered by any tension put upon it while in this condition and the calibration destroyed.

For alternating and direct currents Sir Wm. Thomson's latest instruments are the finest yet produced, but are more suited for standard or station use than as testing instruments. In the electrostatic instruments no current passes through the instrument at all, and so the conditions of a battery or dynamo on open circuit can be found with perfect accuracy. The electrical balances are adapted for both alternating and direct currents. To anybody desiring a fine standard laboratory or station set of large range, none are better than these instruments, expensive though they be. All stations for alternating current work should have a Cardew or Thomson voltmeter, a portable Thomson multicellular electrostatic voltmeter for testing pressure in consumer's premises, &c., and a Thomson ampere gauge. For direct current stations Weston or Cardew voltmeters for station work and line testing should be used, and Thomson ampere gauges for current measurement.

#### TRANSMISSION OF POWER.

In his address at the annual meeting, the President touched upon the subject of electrical transmission of power, mentioning the installation at the Chollar Mine, Virginia City, Nevada. There a Brush plant is used, as then stated, placed 1,680 feet below the surface of the ground, in a chamber 50 feet long by 25 feet wide by 12 feet high, hewn out of solid porphyry. The small stream of water, which drove the wheels at the surface of the mine, was carried down through two iron pipes, one 10-inch and the other 8-inch diameter, connected together at the bottom of the shaft by a Y into a single pipe 14-inch diameter, from which 6-inch pipes lead to the Pelton water wheels' nozzles, and there develops sufficient energy through the generators to transmit to the surface by well insulated cables 450 H.P. The waste water is conveyed away through the Sutro Tunnel, pierced through the side of the mountain for the drainage of the mines—in itself a monument of engineering ability and Western enterprise. This is at present the largest installation in the world for transmission of power by stationary electric generators and motors.

About August last a generator and a motor of exactly the same type as those placed in the Chollar Mine were installed at Messrs. Barber & Co.'s Mills, Georgetown, Ont. The water of the Credit river was dammed over two miles below the mill, and a water wheel and shaft were placed in a building there along with the generator. A copper wire was carried back and attached to the motor, which develops 75 H.P. in the mill.

#### ELECTRIC RAILWAYS.

Four years ago there may be said to have been no electric railways in operation in America. Yet, according to the most reliable sources of information there were 636½ miles of electrically equipped railways in operation, and 700 miles under construction at the end of December, 1889; 1,063 electric cars were then running, and 771 cars were being equipped. The total number of completed roads was 107, and 85 were under construction. Of these roads two were running in Canada, their total length being 10 miles, and these were equipped with 10 motor cars. The first, at Windsor, Ont., with two miles of road and two cars,

has now been at least four years in operation; the other is at St. Catharines, and the length of road is eight miles, and it is equipped with eight cars. Both roads use the Vandepoele system. The road at Victoria, B.C., is now running. The track is four miles long, with six motor cars. The Vancouver road, which is likewise four miles in length, and will be equipped with four motor cars, will be running about the beginning of June. The Thomson-Houston system is used in both cities, and a contract for a short line in Toronto, on which two motor cars will be used, has lately been closed with the Thomson-Houston Company, which has done by far the largest amount of work in electric railways, the Sprague Company ranking next. The table given below shows the amount of work done by various companies and that under construction in January last.

#### ELECTRIC RAILWAYS.

*In operation and under construction, January, 1890.*

Name of System.	In operation.		Under construction.	
	No. of Roads.	No. of Cars.	No. of Roads.	No. of Cars.
1. Thomson-Houston ...	47	490	37	509
2. Sprague ... ..	35	408	33	218
3. Daft ... ..	10	66	5	15
4. Van de Poele ... ..	8	57		
5. Short ... ..	3	17	1	5
6. Bentley-Knight ... ..	1	6	1	20
7. National Electric Traction Company ...	1	1	5	not given
8. Julien ... ..	1	10		
9. Fisher ... ..	1	4	2	not given
10. Henry ... ..	1	4		
11. Rae ... ..			1	4

Within the past few months great activity has obtained in electric railways in the United States, and the two leading companies in this business have contracted for several hundreds of cars each; the lead of the Thomson-Houston Company having increased, while the Sprague Company has over 1,200 motors cars in operation or in course of construction.

The largest electric street railway system in the world is that of the West End Railway of Boston, contracted for by the Thomson-Houston Company, of which the following particulars may be of interest:—At the present time there are 150 cars running, and when completed there will be 600 in operation. Now there are 56 miles of road electrically operated, and 236 are to be equipped. In the power station from 3.30 till 7 p.m. the electrical plant, which is capable of developing, if called upon, 2,500 H.P., usually furnishes from 1,000 to 1,500 H.P. The cars generally in use are 16 feet closed cars, each carrying 30 passengers and towing a similarly loaded car. Such a car, equipped with a single 15 H.P. motor, averages in speed 15 miles an hour on the level, and will pass a grade of 5½ per cent. at the rate of nine miles an hour. Such work is, however, rather severe for constant use, and for heavy work they are using two 15 H.P. motors. The potential used is 500 volts, and the average rate of speed is from 10 to 15 miles an hour. The weight of a motor car equipped is 6 tons. The cost of steam power is from one to four cents. per car mile, taking 100 miles per car per day as a basis; the cost of operation and maintenance, four to 6 cents per car mile on the same basis; the cost of repairs to electrical apparatus is from one and a half to two cents per car mile; cost of management from one to two cents per car mile, and the average total cost of operation is nine and a half to sixteen cents per car mile, according to the number of miles operated.

Unfortunately the severe winters and heavy snowfalls of Montreal and other cities in Eastern Canada preclude the possibility of working electric railways the whole year on our present street roads, but it is a question worthy of the study of members of this society, whether or no it would pay to operate our roads electrically during the seven months of open weather which we get, or if a system of overhead railways along our main traffic thoroughfares operated electrically, and which could be run the whole year round, would not be a good investment.

#### STREET WIRING FOR ELECTRIC LIGHTING.

First, on account of the dangers of breakdown from heavy sleet storms, and the variation in tension of wire caused by the extremes of temperature experienced in Canada, poles should be placed not more than 135 feet apart, or, say, 40 to the mile. They should all be good, sound, straight cedar, 7 inches diameter at the top end and not less than 35 feet long, and should be set in the ground to a minimum depth of 6 feet and securely tamped. The cross arms should be of sound timber, 4½-inch by 3½-inch, well painted and fixed in gains cut in the poles, and secured thereto by lag screws 8 inches long, which would thus enter into the pole about 4½ inches. They should never be attached by spikes only. Wherever telephone or telegraph wires run in the same streets, the poles should be of sufficient height to carry the electric light wires at least 4 feet above them. Bare wire for carrying either high or low tension currents in town should be strictly prohibited. The insulation of the wire should be both fire-proof and weather-proof, and be of such tough texture as to withstand

abrasion should other wires by any means fall across the electric light wires. None but the best double-petticoat glass insulators should be used.

For outside construction some of the English Board of Trade regulations, which might be adopted with advantage in this country are as follows, the numbers given being those of the regulations:—

1. An aerial conductor in any street shall not in any part thereof be at a less height from the ground than 20 feet, or when it crosses a street, 30 feet, or within 6 feet of any building for the purposes of supply.

2. Every support of aerial conductors shall be of durable material, and properly stayed against forces due to wind pressure, change of direction of the conductors, or unequal lengths of span, and the conductors and suspending wires (if any) must be securely attached to insulators fixed to the supports. The factor of safety shall be at least 6, and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50 lbs. per square foot.

5. Every aerial conductor shall be protected by efficient lighting protectors.

6. Where any conductor crosses a street, the angle between such conductor and the direction of the street at the place of such crossing shall not be less than 60°, and the span shall be as short as possible.

7. Where any aerial conductor is erected so as to cross any other aerial conductor, or any suspended wire used, for purposes other than the supply of energy, precautions shall be taken by the owners of such crossing conductors against the possibility of that conductor coming into contact with the other conductors or wire, or of such other conductor or wire coming into contact with such crossing conductor by breakage or otherwise.

11. The insulation resistance of any circuit using high pressure aerial conductors, including all devices for producing, consuming or measuring energy connected to such circuit, shall be such that should any part of the circuit be put to earth the leakage current shall not exceed  $\frac{1}{25}$ th of an ampere in the case of alternating currents. Every such circuit containing high pressure conductors shall be fitted with an indicating device which shall continuously indicate if the insulation resistance of either conductor fall below the conditions required by this regulation.

14. The owner of every aerial conductor shall be responsible for the efficiency of every support to which such conductor is attached.

15. Every aerial conductor, including its supports, and all the structural parts and electrical appliances and devices belonging to or connected with such conductors, shall be duly and efficiently supervised and maintained by and on behalf of the owners as regards both electrical and mechanical condition.

16. An aerial conductor shall not be permitted to remain erected after it has ceased to be used for the supply of energy unless the owners of such conductor intend, within a reasonable time, again to take it into use.

17. Every aerial conductor shall be placed and used with due regard to electric lines and works from time to time used, or intended to be used, for the purpose of telegraphic communication, or the currents in such electric lines and works, and every reasonable means shall be employed in the placing and use of aerial conductors to prevent injurious affection, whether by induction or otherwise, to any such electric lines or works, or the currents therein.

The author considers that rules 7, 13, 14, 15, 16 and 17 should be equally binding upon telegraph and telephone companies whose wires are often as carelessly constructed as those of any electric light company, and have in consequence been quite as blame-worthy for fires originating from electric currents.

#### HOUSE WIRING.

In the interior wiring none but high class rubber insulated wire, protected by an outer linen tape or other efficient covering, should be used.

None but porcelain or slate base cutouts and switches should be allowed, and the sweating of drop wires for single lights on the main wires (such wires being afterwards twisted together and brought down to the lamp socket) should be prohibited.

Wherever lights are suspended by wires, stranded conductors, equal in area to No. 20 standard wire gauge, covered with a good solid rubber coating and protected on the outside by silk or cotton braiding, should be used, and where taken off from the main wires a porcelain rosette cut-out, such as the K.W. rosette, should in all cases be provided, or a wood base rosette may be used, provided it is rendered fireproof.

No switches should be used which do not break contact quickly and automatically, or in which spring copper makes a connection; such copper is heated by the passage of a large current, and, by losing its hardness therefrom often fails to make good connection, and so may cause an arc to form. The Paiste switch is the only one at present made on this continent in which these objections are successfully met.

Fuses for cut-outs should not be interchangeable with others of widely different capacity. Over-loading of wires first designed for lighter loads would then be impossible.

The joints in wires are preferably made with connectors such as the MacIntyre wire joint, as soldered joints on which acid has been used frequently corrode through the excess of acid not having been removed on completion of the soldering, and it has been the author's experience that ordinarily wiremen will not

take the time or trouble to make a good joint with rosin as a flux.

It must be remembered that a low tension continuous current is more liable to cause a fire in case of short circuit between the main wires than an alternating current, owing to the connection which exists directly between the dynamo and the house wires, permitting the entrance into the house of an enormous current, while with the alternating current system the short circuiting of the secondary house wires will only result in the immediate melting of the fine wire fuse in the primary circuit of the converter. There should be no relaxation, therefore, of adopted regulations in favour of low tension direct systems on account of supposed greater safety, a thing which does not exist in their case, but both direct and alternating current systems should be treated alike so far as the wiring of consumers' premises is concerned, and the present standard should be raised, not lowered.

It should not be forgotten that one of the most important elements in the attainment of perfect safety to everybody concerned is the employment by supply companies of properly qualified and experienced labour both for the construction and for the running of plants. It will be found to be very poor economy to employ bell-hangers, plumbers and even shoemakers on work requiring considerable electrical and mechanical knowledge and clear judgment, as is done at the present time in some Canadian stations which might be mentioned, merely for the sake of saving two or three hundred dollars a year in wages, a sum which is much more than counterbalanced by the unsatisfactory results in the lighting and the additional cost of repairs. Nor should it be forgotten that a cheap and poorly constructed electric lighting plant is the worst of all possible investments.

## PROCEEDINGS OF SOCIETIES.

### Physical Society.—June 20th, 1890.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

Mr. C. V. BOYS read a paper on "The Measurement of Electro-Magnetic Radiation," by himself, Messrs. A. E. Briscoe and W. Watson. When Mr. Gregory described his new electric radiation meter on November 1st, 1889, one of the authors said that the observed effects might be due to some cause other than expansion by heating, and that if it was a true heating effect it might be measured thermally. The present communication describes experiments undertaken to investigate the question. The first method employed was developed from the idea that if two fine wires be placed near together and both act as resonators to a primary oscillator, the electro-dynamic attraction caused by the electric currents up and down the wires and the electrostatic repulsion between the charges on them might result in the relative motion of the two wires. From theoretical considerations based on the assumptions that the currents are harmonic in time and space, the authors inferred that the electro-dynamic effect would preponderate at the middle of the wires, whilst the electrostatic repulsion would be greatest at the ends. To cause the attractions and repulsions to conspire, cranked resonators were made; one was fixed and the other suspended by a quartz fibre, to turn about a middle line. These were enclosed in a glass vessel and on starting the oscillator a turning movement was observed, in a direction opposite to that expected. This motion was eventually traced to the electrostatic influence of the oscillator for although the imperfectly conducting surface of the glass acted as a perfect screen from such action when the potentials of the oscillator were varied slowly, it did not do so for changes occurring about 500 million times per second. After adopting means to avoid this disturbance and constructing lighter resonators the experiments were repeated with negative results. From the dimensions of the quartz fibre used it was estimated that a force of 158 millionths of a grain could have been detected with certainty; this would have corresponded to about  $\frac{1}{300}$ th of an ampere in each resonator. It is hoped that by further increasing the sensitiveness of the apparatus and using parabolic reflectors the effect sought for may be detected.

In the second method of attacking the subject, a Joule's dynamometer was employed. This consisted of a glass tube with a partition along the middle extending nearly to the ends. If one side of the tube be warmed, convection currents circulate and deflect an index placed in the stream. A small mirror suspended about one edge and counterpoised, was used for an index and was so sensitive that it was impossible to get the air still enough by any ordinary method of screening. However, by the ingenious device of putting the thermometer within a larger tube kept rotating by clockwork, the difficulties were surmounted. A doubled wire, placed in one side of the thermometer, served as resonator, and on starting the oscillator a large deflection resulted. A similar deflection was caused by applying about one-third of a volt to the ends of the wire. This proved that the effect observed by Mr. Gregory is due to heating. The least rate of heating observable with the air thermometer was found to correspond to one calorie (gramme-water-centigrade) per 24 hours in the whole tube, or one calorie per centimetre of wire in 103 days.

Dr. LODGE asked Sir William Thomson whether, when electric pulses travel along parallel wires with the velocity of light, any

action could exist between them, for two charged spheres travelling together at that velocity exert no mutual attraction or repulsion.

In reply, Sir WILLIAM said he was inclined to think Mr. Boys's treatment of the subject was in the main correct, but it was quite possible that at such velocities the ordinary laws might be modified by the fact that the time taken for the force to be propagated from wire to wire is comparable with that required for the pulse to travel the whole length of the wire. As an example of the peculiar effects of rapid discharges, he said he had seen two copper wires which had been flattened against each other by lightning.

Mr. Boys thought that in his resonators a condition analogous to stationary waves would exist, for the pulses are reflected from the ends.

Dr. LODGE said he had that afternoon observed the action of parallel strips when Leyden jar discharges were passed through them. The strips gave a kick at each discharge.

Mr. GREGORY mentioned that in trying to increase the sensitiveness of his meter so as to measure the variation with distance, he had found that two resonators in proximity interfered with each other. He had, however, succeeded in increasing the sensibility about five-fold.

Prof. WORTHINGTON asked if it was possible to measure the energy of the oscillator, and also whether the quantity caught by the resonator could be estimated from the solid angle it subtended at the source of energy, wherever that might be.

Prof. PERRY considered it easier to infer the energy of the source from that received by the resonator.

Dr. LODGE said the energy of the source could be easily measured. The power radiated was enormous whilst it lasted, vastly exceeding that of tropical sunshine; if it could be made continuous the apparatus would soon be red hot. The energy radiated, he said, converges on the resonators and hence the solid angle method of estimating the amount received would be erroneous. Moreover, the source was not at the oscillator, but at a quarter wave length from it, and most of the energy returns to the oscillator; only a small fraction is splashed off and sent into space. Small oscillators radiate powerfully because the quarter wave lengths are small, whereas the slow oscillators or alternators used commercially radiate very little of their energy. The exact law of variation of intensity of radiation with distance was rather complicated, but the theory had been completely worked out by Stokes in 1848.

Mr. BLAKESLEY thought the energy that returns to the oscillator would be available for subsequent radiations.

Dr. LODGE pointed out that wires or other resonators placed within the quarter wave length would intercept part of the returning energy.

Two communications, "Notes on Secondary Batteries," by Dr. GLADSTONE and Mr. HIBBERT, and "An Easy Rule for Calculating approximately the Self-induction of a Coil," by Prof. J. PERRY, were taken as read.

In the first of these, the authors show cause for believing that the beneficial effect produced by adding sodium sulphate to the ordinary electrolyte is due to its power to diminish local action between the electrolyte and different parts of the lead plates. As regards the chemical actions which take place during the working of ordinary cells, they see no reason to doubt the view put forward by one of them in 1882, that the substance produced in the voltaic reaction is ordinary lead sulphate  $Pb SO_4$ . They also conclude that the high E.M.F. of a cell immediately after stopping the charging current is due to the inequality of acid strength near the two plates, and the gradual fall of E.M.F. is caused by the equalisation of strength produced by diffusion.

Prof. Perry's rule relates to hollow cylindrical coils, and is expressed by the following formula:—

$$L \text{ (in secohms)} = \frac{n^2 a^2 + 10^7}{1.844a + 3.1c + 3.5b}$$

where

- $n$  = number of windings,
- $a$  = mean radius of winding in centimetres,
- $b$  = axial length,
- $c$  = radial depth of winding,

and  $b$  and  $c$  are less than  $\frac{a}{2}$ .

The time constant of such a coil is given in terms of the volume of copper ( $v$ ) in cubic centimetres by

$$\frac{L}{R} = \frac{v + 1,000}{.728a + 1.33c + 1.5b}$$

and the conditions for making this small are pointed out in the paper.

A paper by the Rev. T. Pelham Dale was postponed till next meeting.

#### Royal Society.

"Contributions to the Molecular Theory of Induced Magnetism." By J. A. EWING, F.R.S., Professor of Engineering in University College, Dundee. (Abstract of paper read June 19th).

After referring to the discussion by Maxwell of Weber's theory, which ascribes the magnetisation of iron and other magnetic metals to the turning towards one direction of molecules which are already permanent magnets, and to suggestions by Profs. Wiedemann and Hughes, and lately by Mr. A. E. Kennelly (the *Electrician*, June 6th and 13th of 1890), the writer describes experiments which he has made bearing directly on the molecular

theory. The experiments have been made by grouping near to one another a large number of small pivotted magnets each free to turn about a fixed centre, and studying the configuration which the group assumes and the manner in which it yields when an external magnetic force is imposed. The results do not support the idea that the molecular magnets form closed chains in unmagnetised iron. They lead, however, to the important conclusion that no arbitrary conditions of directional constraint need be postulated to make the behaviour of the molecular magnets agree with what is known about magnetic quality.

In the writer's view the molecular magnets are perfectly free to turn in response to external magnetic forces, except in so far as they are constrained by the magnetic forces which they mutually exert on one another. This theory is briefly discussed in the paper in relation to the form of the magnetisation curve, to the character of cyclical processes, and to the known effects of temperature, vibration, stress and so forth, and the following conclusions are stated:—

1. That in considering the magnetisation of iron and other magnetic metals to be caused by the turning of permanent molecular magnets, we may look simply to the magnetic forces which the molecular magnets exert on one another as the cause of their directional stability. There is no need to suppose the existence of any quasi-elastic directing force or of any quasi-frictional resistance to rotation.

2. That the intermolecular magnetic forces are sufficient to account for all the general characteristics of the process of magnetisation, including the variations of susceptibility which occur as the magnetising force is increased.

3. That the intermolecular magnetic forces are equally competent to account for the known facts of retentiveness and coercive force, and the characteristics of cyclic magnetic processes.

4. That magnetic hysteresis and the dissipation of energy which hysteresis involves are due to molecular instability resulting from intermolecular magnetic actions, and are not due to anything in the nature of frictional resistance to the rotation of the molecular magnets.

5. That this theory is wide enough to admit explanation of the differences in magnetic quality which are shown by different substances, or by the same substance in different states.

6. That it accounts in a general way for the known effects of vibration, of temperature and of stress, upon magnetic quality.

7. That, in particular, it accounts for the known fact that there is hysteresis in the relation of magnetism to stress.

8. That it further explains why there is, in magnetic metals, hysteresis in physical quality generally with respect to stress, apart from the existence of magnetisation.

9. That, in consequence, any not very small cycle of stress occurring in a magnetic metal involves dissipation of energy.

#### NEW PATENTS—1890.

9263. "Improvements in electric cut-outs and switches or other circuit breakers." J. DRUMMOND. (Communicated by R. O. G. Drummond and D. A. Bremner, South Africa.) Dated June 16.

9274. "Utilising the waste or other water power of rivers, canals, tides, &c., for electrical or other purposes, by constructing or erecting lock, shute, or other weirs with hollow iron piers and foundations or casings upon iron screw or ordinary piles, and filling with concrete, &c., to carry water wheels or encased dynamo water wheels of any kind, or by floating dynamos on such dynamo water wheels." P. H. WILLIAMS. Dated June 16.

9275. "Constructing water wheels of any form, and providing or utilising space in the interior for enclosing or attaching dynamos of any kind, or attaching encased dynamos to water wheels of any kind, or to their spindles or shafts, or floating dynamos." P. H. WILLIAMS. Dated June 16.

9343. "A new and improved flexible-jointed pipe for fluids, gases, &c., and for insulation of electric or other wires." R. M. HAGUE. Dated June 17.

9357. "Improvements in switches for electric glow lamps." A. BARKER. Dated June 17.

9361. "Improvements in electric reduction of metals, and in apparatus therefor." T. L. WILLSON. Dated July 17.

9395. "Improvements in electrical apparatus for the production of rotary motion." O. ROMANZE, of and on behalf of the firm of ROMANZE and WEISE, and F. W. WHITE. Dated June 17.

9602. "Improvements in the distribution of electrical energy." SIEMENS BROTHERS & Co. (Communicated by Siemens and Halske, Germany.) Dated June 20.

9668. "Improvements in elevating and lowering electric lights." J. P. HEBENDAHL, G. MILLER and E. F. WARNER. Dated June 21. (Complete.)

9683. "Improvements in electrically driven percussive tools, and in the means of operating the same." L. B. ATKINSON. Dated June 21.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

3424. "Improvements in dynamo-electric machines and motors." J. SWINBURNE. Dated February 26. 8d. Claims:—A generator or motor for direct currents, having: 1. A reversing armature core with the commutator connections embedded in it. 2. A reversing armature with the commutator connections thin where they pass through the reversing field. 3. A reversing armature core with each commutator connection passing over the outside only once, substantially as set forth. 4. Reversing magnets adjustable as to position, substantially as described. A synchronising alternating current motor: 5. In which the current-turns on the field magnets are decreased when the load increases. 6. Excited from its own armature. 7. A self-exciting alternating generator or motor, with two or more exciting coils on the armature giving currents differing in phase, substantially as and for the purposes set forth.

3671. "Improvements in or relating to winding and synchronising clocks by electricity." A. J. BOULT. (A communication from R. J. Pouchard, of Paris.) Dated March 1. 8d. The object of the present invention is to design mechanism by means of which clocks driven by weights can be wound up and synchronised or regulated electrically by passing an electric current every 24 hours over a special wire or an ordinary telegraph line. 7 claims.

4846. "Improvements in electric light fittings and Conductors." C. K. FALKENSTEIN, E. ROUSSEAU, and C. K. FALKENSTEIN. Dated March 20. 6d. Claim:—An insulated conductor for two or more wires, consisting of a core having grooves, in which the wires are laid, and a tube covering the core and wires.

5676. "Improvements in electric bells." D. REID and J. KEAN. Dated April 3. 8d. The inventors employ a relay connected to the battery and bell, and they use the same battery for actuating both the relay and the bell; one terminal of the coil of the relay is connected to one pole of the battery direct, and the other terminal of the coil of the relay is connected to the other pole of the battery through the bell-push, or other contact maker, which may be at a considerable distance from the bell. One pole of the battery is also connected to the armature of the relay, while the other pole of the battery is connected through the circuit of the bell to a stop of the armature. 1 claim.

5768. "Improvements in wooden casings for electrical conductors." W. G. DE FORGES GARLAND. Dated April 4. 6d. Claim:—A wooden casing or protective covering for electrical conductors, adapted for being readily fixed in position without risk of injury to the insulation, substantially as described with reference to the drawings; the same comprising a grooved fixed part and a removable covering piece (or pieces), suitable for being applied laterally to the said fixed part, and for engaging therewith.

7023. "Improvements in electric meters." R. SNOWDON. Dated April 27. 1s. 1d. Relates to that type of electric meters known as "motor meters," and the improvements consist in the construction of the meter in such a manner that the motion of the motor is retarded or resisted by a viscous fluid resistance, and so also that the current or currents passing through the armature of the meter is, or are, exclusively the current or parts of the current to be measured, as and for the purposes described. 12 claims.

7127. "Improvements in or connected with the brush contacts of electric railways." G. E. VAUGHAN. (Communicated from abroad by S. Trott, of Nova Scotia.) Dated April 29. 8d. Has for its objects to more effectually insulate the conductors connected with the contact brushes, to protect them from injury, and to provide an efficient carrier for the conductors and contact brushes. 3 claims.

7198. "Improvements in the manufacture of electric arc carbons." W. E. ADENEY and L. SAUNDERSON. Dated April 30. 4d. Powdered gas coke is mixed with powdered coal in the proportion of coke varying from 80 to 50 per cent., and that of coal varying from 20 to 50 per cent. To this mixture is added 1 to 10 per cent. of infusible or difficultly fusible substances such as—compounds of aluminium, silica, calcium, iron, &c., such as glass, cyanite, kaolin, bauxite, asbestos, pumice, felspar, gadolinite, samarskite, quartz, zircon, limestone, strontianite, dolomite, witherite, phosphate of lime, braunite, titanite, chrome iron ore, wolfram, molybdenite, fluorspar, cerite, cryolite, phosphate of aluminium, magnesite or compounds of nickel and cobalt. After careful mixing the whole is introduced into iron moulds and heated under pressure, at first gently, but finally very strongly. The carbon rod so made, if found too porous, is heated and introduced into hot coal tar, and the whole heated (preferably in vacuo) for some time. It is then taken out, and its surface cleaned, and then introduced into a mould and again heated under pressure. 5 claims.

7428. "Improvements relating to electric accumulators or secondary batteries, and to the manufacture of plates or electrodes therefor." C. POLLAK. Dated May 3. 8d. The plates are prepared by mechanically forming grooves or notches on the two sides of sheets of lead, these sheets being caused to pass between two cylinders covered with wire gauze, or carrying indented discs, or alternately full discs and indented discs, in such a manner that the grooves or notches made on either side of the plates in these rolling motions shall be of a sufficient length and depth to receive and maintain spongy lead. 5 claims.

8459. "Improvements in dynamo-electric machines and electro-motors." T. L. WILLSON. Dated May 21. 11d. Relates to a drum-shaped armature, the conductors of which consist of a single layer of longitudinal bars, with commutating brushes bearing upon these bars at one or both ends in line with the fields of force, to conduct the current to and from each bar during its passage through the magnetic field. The bars are thus cut out of the circuit as soon as they pass beyond the field, and remain with open terminals during their period of inactivity. 7 claims.

20288. "Improvements in conduits for electric conductors and combined conduits and conductors, and in the manufacture of the same." H. B. TATHAM and J. TATHAM. Dated December 17. 8d. The object of this invention is to so construct a conduit for electrical conductors that it will provide an effective insulation for the same, can be manufactured at small cost, and will be practically indestructible under ordinary conditions of use. 5 claims.

## CORRESPONDENCE.

### The Lineff Improved System of Electric Traction.

In your last issue I observe a note stating that a trial of the above took place on Wednesday, last week, and that a notice of the system appeared in the REVIEW of May 9th. I have compared the latter notice with those which were published by your two electrical contemporaries last week, and find that beyond a few details there is no difference, although the description in the REVIEW was given six weeks previously. It is, however, not to this that I wish to draw your particular attention, but to the trial and to the remarkable statements made by one of your contemporaries.

I am informed by one who was present at the trial, that the runs made by the open car extended over a considerable length of track—namely, about 25 yards! This is, indeed, a remarkable distance to make a demonstration of any system of electric traction; and yet, according to one electrical journal, "the trial seemed perfectly successful." Now, I contend, and I think with reason, that the trial was not a demonstration of the system, and that the working capability of the car was not demonstrated. To run a car to and fro 25 yards is purely a laboratory experiment, if such a phrase is admissible, and proves nothing. As far as I remember, in reading of trials of other systems of electric traction, whether third rail, "series," or accumulator, the demonstrations have been made on tracks at least one mile, and sometimes several miles long. I think, therefore, that in the case of the Lineff system a trial should have been made on a moderate length of track, and, until such is done, the system should be ignored.

Then, again, the same contemporary states that it has been informed that the "car has been run at the rate of 30 miles an hour." I should like to know where—possibly on the 25 yards track. The statement is decidedly absurd. There is not, I believe, a single electric car in the United Kingdom which has ever attained that speed. On the Barking line it is claimed that the accumulator cars have been run at 20 miles an hour, a statement which is very doubtful, considering the power of the motors, the heavy and clumsy build of the cars, and the nature of the line. Even in the United States I do not think there are any electric cars which have attained the rate of 30 miles an hour.

I am informed that the members of the Chiswick Local Board who objected to the old open slot system of Mr. Lineff, have expressed themselves as satisfied with the new method. This is interesting, considering the length of track upon which the car was run when those gentlemen were present over a fortnight ago.

There are three points upon which I should like to be enlightened. It has been found that none of the front and rear sections of the surface conducting rails are charged when the car is over any two charged sections. How will this be in rainy weather, what will be the effect when snow is on the ground, and how will the snow be removed? Moreover, the Press view last week was, I am told, arranged in an unsatisfactory manner.

F. Baines.

June 30th, 1890.

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## SCIENTIFIC REPORTING.

A FEW weeks ago some specimens of an incandescent lamp were submitted for test to a gentleman whose name it is needless to mention. It was claimed that the new lamp, which is said to be outside the Edison-Swan patents, was also considerably less wasteful of electrical energy per candle-power than those now holding the monopoly of incandescent electric lighting. The lamps to which we refer were labelled for certain voltages, and in the table below the details of the experiments, which we have every reason to believe are correct, may be seen :—

Lamp Mark.	Actual Volts.	Current.	Candle-power.
98	98	·600 ampère	13·4
110	110	·525	12·7
106	106	·600	12·7
90	90	·800	14·13

We may incidentally mention that several samples of the lamp, which do not seem to possess much uniformity, probably on account of imperfections in a new manufacture, were also submitted to the same expert so long ago as last October, labelled 100 volts 16 candle-power ; but it was found that to bring them up to this luminosity required in the respective instances 104 to 106 volts. Being thus over-run, the result reduced to watts per candle-power showed a slight saving over the electrical energy generally assumed to be required in an Edison lamp incandesced to the same degree.

We believe it is safe to say that 60 watts for a 16 candle-power lamp is a maximum for any really good manufacture. Many makers or consumers would doubtless say—and if they feel convinced we allow too great margin we hope they will say—that 50 watts is nearer the mark, at all events when the filaments are first put into operation, the difference between old lamps and new in this respect being too well known to need further discussion.

This being so we wish to bring before the notice of our readers the report of a Professor of high renown, with every convenience at hand for conducting the

tests on the most scientific lines, and who, we believe, enjoys the confidence of the public in no ordinary degree. The lamps he was requested to examine were, we understand, selected from the same batch as those figuring in the above table, and this is his verdict after a comparison with Edison-Swan lamps :—" X's lamps consumed 3·12 watts per candle-power, Edison-Swan 4·29 watts per candle-power, thus proving that X's show an effective saving of 25 per cent."

Our readers will not fail to notice that there is no reference here to the voltage and measured candle-power of either X's lamps or those of Edison-Swan, therefore we need not question the intelligence of those who have even a slight acquaintance with lamp tests by commenting upon the value of such figures ; but upon examination of the foregoing table it will be seen that in X's lamps the labelled voltage in no case brought up the degree of incandescence to 16 candles, a result in conformity with previous tests. Calculating from these the electrical energy consumed it will be seen that instead of showing a saving of 25 per cent. over the Edison-Swan, X's lamps, they all demanded even more than those, probably old and half worn out, which came under the notice of the Professor.

Now we ask, is it fair to the owners of X's lamp patents, to the public, who will doubtless eventually read the report, to the electrical trades, and particularly to the Edison-Swan Company, to give such a vague, misleading, and absolutely valueless statement as that which we quote ? By overrunning we may make the watts per candle-power almost as low as we like, short of the breaking limit, or as uneconomical as needs be if working below the normal difference of potential at the lamp terminals, and the knowledge of a few simple facts like these would save much time, expense, and disappointed hopes alike to both financiers and inventors.

We almost feel inclined to offer to carry out a series of tests ourselves, and publish the results if makers would submit their lamps to our examination ; we would

at least test them under proper conditions, and give the necessary data from which experts and the public could form their own conclusions. Perhaps some of our readers will kindly favour us with some incandescent lamp figures as they exist at the present day?

### A CHALLENGE.

THE meeting of the Tramways Institute of Great Britain, which is discussed on another page, was, to the electrical fraternity, of interest only for the argument which took place on the score of electric traction. We need not here reproduce any of the points at issue, for they are fully set forth in their proper place; but we cannot let the matter slumber without an effort to revive so important and interesting a controversy. In our last issue we referred to the Elieson system as costing nearly three times the amount of the contract price per car mile, viz.,  $4\frac{1}{2}$ d., and we have now every reason to believe that the cost of electric traction on the Barking line is something like twice the contract figure. Data in our possession point to this result, and Mr. Willbond's assertions bear out to a great extent the likelihood of their accuracy; we cannot, however, at the moment publish them in detail, but we do challenge the General Electric Power and Traction Company, Limited, to bear out the statements which, on the authority of their managing director, appeared on page 72 of the REVIEW for January 17th of this year, when it was asserted that the working of the Barking line had shown it to be operated at a profit. This becomes all the more necessary when it is remembered that the Barking line formed one of the valuable properties for which the sum of £242,000 was modestly asked (*vide* articles on *Traction*, ELECTRICAL REVIEW for May 23rd and June 6th).

There is at the present moment too great a tendency to float companies, utterly irrespective of the merits of the structure on which they are based, and we feel, therefore, that it is best to be outspoken, for truth, like murder, will out, and there is no good in mincing matters at a crisis.

It is folly to work a line and pretend to be making a profit if the expenses are double the receipts; the only frank course to pursue is to state the actual facts, and then to seek for the means of reducing the working cost until traction by electrical energy can compete on its own bottom with the present means of tramcar propulsion.

Perpetual Motion  
Realised at Last.

A CORRESPONDENT sends us the following delightful cutting from the *English Mechanic*, which, with the electrophonoscope, we strongly recommend to the notice of enterprising company promoters. In either case it would be unnecessary to tell off an expert to examine into the stability of the business or the probity of those connected with the respective schemes:—

I wish to light my house with electricity, and it has struck me that I might do so without the aid of an engine. If I were to use two dynamos, starting one of them by hand, and using half of the current that I got from it to drive the other as a motor, letting the other half light the lamps, the motor would then be used for driving dynamo No. 1. I should be much obliged if you

would tell me (1) if this has been tried before?—and if not, could I take out a patent for it, as it is entirely my own idea? 2. How much wire should I put on each of the dynamos to light 20 8-volt lamps (not arc lamps)? And is it necessary to have the armature of iron, or would brass do as well? As I am very anxious to become an electrician proper, could you recommend any firm that would allow me to work for a few months in their shops, for which I would give my services, that I might get an insight into the practical work, as I understand the theory of the thing pretty well?—A WOULD-BE ELECTRICIAN.

Perhaps the best testimonial which this "Would-be-Electrician" could offer to a business firm is his self-made assertion that he "understands the theory of the thing pretty well."

Taking the Lead  
of America.

How Prof. Hughes and Mr. Preece must have chuckled over their huge Electrophonoscopic joke. It is not given to the lesser lights of science to conceive, much less to carry out, such an elaborate delusion which, it is not too much to say, has set the whole civilised world by the ears. Prof. Pepper, of Polytechnic fame, years ago devised many very clever optical illusions and he was looked upon as a scientific nobody; but it has been reserved for this age of enlightenment to laud to the skies the reproduction of an old trick with which every schoolboy is supposed to be familiar. "At last, it seems, says *Life*, "we have taken the lead of America in producing a triumph of electrical invention. To be able to see and converse with a friend on the other side of the Channel, for instance, will be an achievement that will simply abolish all the anxiety of absence and all the sorrow of parting. The 'Electrophonoscope' is certainly a marvellous advance in a science which of late years has made such giant strides, and it is most gratifying to know that we are indebted for it to the genius of two of our own countrymen." We fear *Life* does not know much of the subject upon which it treats. Fancy after getting rid of a "friend," one fondly hopes for ever, to be electrophonoscopically bothered by his presence from across the Channel! Luckily we are not likely to suffer any such misfortune until the Channel tunnel is constructed; then, if our two countrymen are still in existence and in full possession of their faculties, Heaven help us.

Increasing Loco-  
motive Traction  
by Electricity.

THIS subject is one which continues to excite interest in America; it is undoubtedly an important one in view of the adoption of electric locomotion with light vehicles. Mr. Elias E. Ries, whose experiments on the subject have been questioned as to their practical accuracy, are stated by Mr. C. Selden, in a paper read before the Railway Telegraph Superintendents' Convention in America, to be correct, as the result of experiments he has made. Certainly, according to the tests made with a model motor, the passage of a current between the wheels and rail, whether the latter were clean and bright, or highly greasy, increased the adhesion to a very marked extent. These results, it may be recollected, do not at all accord with experiments recently described in our pages; to what is this discrepancy owing? Mr. Selden, in his paper, admits that practical tests alone can determine whether sufficient power can be had from a proper dynamo and auxiliary engine to show even an increase of 25 per cent. in the adhesion in the case of a full sized locomotive. In fact, the question seems to be, to a great extent, whether the power required to give the adhesion may not be more profitably employed in increasing the power of the motor driving the engine, the latter being

more heavily weighted. It is stated that Mr. Ries is making arrangements for a trial which will determine conclusively the real value of the idea; the results of this trial will be awaited with interest, although we do not anticipate that an approach to electric welding in this form will prove advantageous. Adhesion between wheels and track must be obtained by some more simple method, for this can only be looked upon as a sheer waste of electrical energy at best.

The Overhead Wires Bill. A VALUED correspondent thinks our remarks last week on the overhead telegraph lines are not quite right. He points out that the Bill as it originally stood was one for the formation of subways in all streets, to compel gas, water, and electric companies to move their mains at their own cost into these subways, and afterwards pay a very high rent charge for the use of them. To those people who had already worked out a system of culverts, which are practically subways placed in the most handy position for serving the houses, the proposal was, of course, a very serious one; but at an early stage the subway clauses were abandoned, and the Bill was confined to the question of the regulation of overhead wires. Here is the point on which our correspondent falls foul, for he considers it would have been, and we think with reason, manifestly unjust to have compelled all the existing companies to place their wires underground at great cost, and then for the London County Council to issue licenses to rivals to carry on a complete system of overhead wires to serve identically the same district, and thus introduce an extremely unfair competition. Still, he thinks that even had the Bill passed through, the committee would have seen this unfairness, and restrained the County Council from giving such licenses where the district was already well served by subterranean conductors, and restricted the license to existing companies for the purpose of trunk lines to serve outlying parts or for scattered customers in thinly-populated portions of their area. Had such a contingency been provided for, our correspondent believes the Bill would have met the hearty support of those, himself included, who opposed it.

Overhead Wires. A Householder's Views. COMING nearer home our friend confesses that, as a house owner who had given permission for the erection of telephone poles and wires on his residence, he has a heartfelt sympathy with the speakers in the House of Commons who complained of the annoyance caused by the workmen who have to enter houses for the purpose of attending to the wires. "The British workman," quoting the writer's remarks, "is bad enough to manage when he is your own servant, but when he is not under your control his behaviour is such that it increases the discomforts of housekeeping enormously. The one subject of stair carpets is a perfectly correct one to mention. It must be admitted that a great deal of the domestic happiness of the average householder depends on the comfort and good temper of his servants, and I assure you that the tempers of the best of servants can be ruined by allowing workmen to tramp up and down stairs at all frequently. In all well regulated households the domestics do their work at certain hours, the house is cleaned down at a certain time, and if workmen come in after these hours and dirty the stairs and passages, as they invariably do, the equanimity of the servants is disturbed for the whole of the day. It is perfectly true also about thefts. It may be that the

workmen are perfectly honest, but they become the 'cat' responsible for all breakages and robberies which may have been committed by the servants themselves." He concludes as follows:—"If overhead wires are to be regulated and permitted, and attachments made compulsory, I am quite certain that the companies will have to maintain an outside ladder for the purpose of giving access to them, and that such outside ladders ought to be fixed much more frequently than is at present the case. They would act very effectually as fire escapes, and might be insisted upon with great advantage by the County Council. It should be fixed in a convenient situation at the back of the house in such a manner that it can be used as a fire escape, and provided with a gate or door at the bottom, so that it can be opened from the inside by anybody escaping, but would not be accessible to thieves or to anyone but the people owning the house or the officials of the overhead wire company." We cannot but think that the idea of the ladder is not happy so far as protection from burglars is concerned. Let our friend imagine a thief in his house, entering from the front, and, being disturbed, escaping by means of the very apparatus (opening it from the inside), which is intended to save life and defeat the ends of midnight prowlers.

Prospectus Making. HAD time and space allowed of such a course, we might have spoken last week at still greater length on the prospectus of the Okonite Company. In comparing its uncertain future with the present condition of the Silvertown and Telegraph Construction and Maintenance Companies, it must have been overlooked by the promoters that the profits of the latter powerful organisation are derived from the manufacture of goods which have nothing in common with okonite, and, although the reputation of the Silvertown leads is deservedly high, the profits from this source probably form a very insignificant part of those accruing from the whole undertaking. If, on the other hand, equally deserving firms had been cited, such as Henleys, the Helsby Company, Messrs. Walter T. Glover & Co., the London Electric Wire Company, &c., no such profits have been made, and as okonite must compete with the productions of these firms, it would have been only fair to have at least mentioned them. Moreover, to one who knows how difficult it is, and the unremitting care and attention required to work up a turnover in electric lighting with sufficient to pay a fair dividend, even on a modest capital, the task of attempting so to do on a sum of £440,000 appears stupendous. We should look upon the managing director who could successfully perform such a feat with respectful admiration.

The Rival Systems. WE shall be greatly interested to see what is said further on the subject of our last week's leaderette. It must be of great value to the trade in general to have the matter ventilated, and we do not for a moment think there is nothing to be said on the side of the alternating current system; but hitherto the companies using it have been remarkably chary in saying it, and if they do not come forward with explanations it is more than likely that a very bad impression will be made. It may further be pointed out that the balance sheets of a good many companies have been published, and in all cases the engine room costs of the alternating current appear to be excessively high, and hitherto no attempt has been made to explain them.

ON DESIGNING SWITCHES FOR  
ELECTRIC PLANTS.\*

By OLOF OFFRELL.

IN the early days of electric lighting very little attention was paid to the accessories of an electric installation, and especially to the devices known as switches. Naturally enough, as long as the dynamo and the lamp were in a primitive state, and, consequently, there was a great field for improvement in that direction, so long no attention would be given to less important matters, mere details, although quite important ones after all.

Only within the last two or three years have inventors turned their attention toward perfecting the switch, which has now become a *sine qua non* in almost every kind of electric installation; but we have now very ingenious and practical devices of this kind in the market.

The purpose of this article is to give some practical points on designing switches, brought out by experience.

One of the first points to consider in designing a switch is its capacity, that is, how many amperes of current it can safely carry over and through its contacts without appreciable heating. On this point there seems to exist a great difference of opinion. Not any two switches of the same rated capacity have approximately, or anywhere near approximately, equal contact surface. While a large contact surface is a decided advantage, we soon reach a limit, which we cannot pass without materially increasing the size and consequently the cost of the switch, and then the question arises—what is the smallest allowable contact surface in square inches per ampère to be carried that we can use with a factor of safety large enough to prevent any appreciable heating? The writer has found 0.01 square inch surface per ampère to be a good rule, below which it is not advisable to go. In arc light or constant current switches, which generally do not carry over 10 amperes, we can, and usually do, make the contacts a good deal larger, from 2 to 4 times, as we are here not so much restricted by a bulky appearance and cost as is the case with an incandescent switch.

It is always preferable to have contact surface on both sides of the lever carrying the current, *i.e.*, double contact springs; as, in this way, a better and more trustworthy contact is obtained. The contact springs must not be of too thin material; preferably they ought to be made of two or three thicknesses of spring copper, which are riveted to the binding post to which the conductor is secured. The very best way of securing the contact springs is to set them in grooves milled out for the purpose in the base of the binding posts and then rivet them. The contact spring ought to be split or cut up to almost its entire active length in two to four parts, depending upon the size of switch, because this makes it more flexible; and if there is an uneven spot on the contact surface of the lever, it will adjust itself to the unevenness and still make a good contact.

The contact springs or the lever must be so shaped that the lever leaves the contacts along their entire length at the same time. If it does not, the spark, in throwing the switch open, will concentrate itself at the point of last contact, and, in case of a heavy current, burn or fuse it.

The cross section of those parts of the switch that have to carry the current must have a conductivity according to the current to be carried, corresponding to 800 to 1,000 amperes per square inch.

The action of the switch must never depend upon springs, spiral or flat, through which the current passes, as the current will invariably more or less heat and take the springiness out of them, thereby causing the switch to give out.

Never let the pivot-bearing of the lever form one terminal of the switch, as the current in passing through the bearing will heat it, no matter how carefully it is

made, and sooner or later put the switch out of order. Each terminal ought to have contact springs for itself. This might make the bridge cost a trifle more, but it is a far better construction. The general practice to-day among leading manufacturers is to make such independent contacts for each terminal.

The set screws for holding the conductors in the binding posts ought to be large enough to stand a good tightening. Preferably they ought to be of iron, with square heads, so as to be tightened with wrench wherever the size of the switch allows it. The number of threads in the binding-post into which the screw engages must be large enough, so that there will be no danger of stripping the threads in tightening the screw.

In the case of a switch operated altogether by hand, without assisting springs, the lever ought to be provided with a stop device, which keeps the switch open, preventing it from accidentally closing the circuit. This is especially important in alternating current switches on the primary circuit, where an accidental closing of the circuit can endanger lives.

The handle is, of course, always made of wood or other insulating material.

The base of the switch ought to be made of fire proof, insulating material, for which slate, porcelain, hard rubber, moulded mica, &c., are suitable, and is now extensively used. If the base is made of wood, the front side ought to be covered with mica, so as to prevent the spark, that possibly can be formed, from setting the base on fire.

The cover in switches for low tension currents is generally made of metal, but it must always be insulated from those parts of the switch that carry the current. On the inside of the cover is generally placed one thickness of thin vulcanised fibre.

The practice so far has been to make all station switches, whether for high or low tension, open, *i.e.*, without cover; but the probability is that before long they will be provided with an insulating covering, at least where high tension alternating currents are used, so as to prevent accidents to the attendants.

The use of single pole switches is comparatively rare, especially in distribution of electrical energy at constant potential; switches are generally made with double poles, which in every case are to be preferred as by them a certain part of a circuit or a certain machine in a system can be completely disconnected by one movement of the switch lever. This is absolutely necessary where high tension alternating currents are used, and is compulsory wherever rules of a Board of Electrical Control or a Board of Fire Underwriters are adopted.

In order to prevent the possibility of the lever stopping at an intermediate point, whereby only a part of the contact surface would have to carry the whole current, resulting undoubtedly in destroying the switch, and further to prevent forming a spark at the instant of breaking the circuit, so-called snap switches have been invented. They are so constructed that the switch lever, once started by the operator turning the handle, is brought to its furthest position by means of one or two springs, independently of the movement of the handle. These springs are carried over the centre by turning the handle to a certain point, but act from that point independently of the handle. Thus all danger of the switch stopping on an intermediate position is prevented, as is also the forming of any destructive arc in opening the circuit.

For these reasons all switches outside of central stations ought to be made "snapping," *i.e.*, to quickly close and open the circuit independently of the speed with which the operator turns the handle. There are several meritorious designs on this principle in the market.

Constant current switches are made on a somewhat different principle from constant potential switches, as in this case the circuit must never be opened. The duty of a constant current switch is to cut out a certain loop or part of the circuit; but as the loop carries the whole current, it would interrupt the service on the whole line to open the circuit in the loop. The switch

\* *Electrical World.*

must therefore short circuit the loop before it disconnects it. Even these switches are made "snapping," although there is no absolute necessity for it if the short circuiting is properly done before the cutting out.

As a conclusion, I will say a few words about the latest developments in switches, which I have been recently engaged in designing, and in which the most important conditions for a first-class switch are fulfilled. These switches are to be used on the alternating circuits in connection with the underground cables in the New York subways to disconnect converters from the main circuit.

The requirements to be fulfilled by these switches are that they shall be water, moisture, and fire proof, and have an insulation resistance at least equal to that of the underground cables; in addition to which they must be so arranged that moisture cannot enter the insulation of the exposed ends of the cables terminating in the binding posts. The cables from the subway enter a cast iron box at one end, passing through a special kind of clamp screwed into projections on the outside of the box. These projections are made hollow to receive insulating cups, through which the cables pass to the binding posts. The cups are filled with insulating compound after the cables are in place, which then surrounds the bare ends of the wire, preventing moisture from entering the insulation. The cables leading to the converters pass through pieces of gas pipe screwed into corresponding holes on the opposite side of the box, and are soldered to them.

The switch is a double pole quick break switch, which is mounted on a hard rubber base. The switch stem projects outside the box through a stuffing-box in the lid, and can be operated from the outside by a handle, or the lid is screwed on and made water-tight by means of soft rubber and cement.

## ELECTRIC CAR TRUCKS.

By FRANK B. LEA.

IN a recent article (see the ELECTRICAL REVIEW of 27th June last, page 722) the writer endeavoured to show the possible course that will be followed in the development of electric traction so far as regards the type of car employed: and it was then seen that—apart from questions concerning the traffic—the most favourable ratio between paying load and dead weight of the car is obtained by using vehicles of large size.

That is, if the traffic may be fairly met by running large cars with heavy loads, the dead weight to be moved (and therefore the waste power exerted) is much less in proportion to what it would be with smaller vehicles designed to carry, perhaps, half the number of passengers.

It is assumed, therefore, that the electric tramcar should—for these reasons alone, and apart from other considerations—be made as large as possible. Of course there must be many instances of lines where a frequent and light service becomes necessary; but cases are perhaps equally numerous in which the traffic throughout a greater part of the day is met by running large cars at considerable intervals, any additional rush of traffic being accommodated by extra cars in the morning and evening.

There are, however, serious restrictions to the size of cars built upon the ordinary plan, not by any means the least of these being the unpleasant see-saw rocking motion ("teetering," as it is called in the United States) which appears to be an inevitable accompaniment of a long car having seats on the roof and provided with the ordinary central under-frame on four wheels.

Then, again, the rigid connection of wheels and axles in such a system places a low limit on the ability of the car to run smoothly and safely round sharp curves, such as are frequent on street railways.

A much pleasanter motion as well as extreme ease in traversing curves is obtained by the use of small four-wheeled bogie trucks placed one at each end under the

car frame, which pivots on them, and slews round on the pivots in traversing curves.

Advantages like these will probably more than compensate for the extra cost incurred, especially in view of the saving effected in the power required for traction.

There is at any rate no harm in assuming that many electric cars will and must be built on such a plan; engineers, indeed, are not wanting who predict for high speed railway work the almost exclusive employment of bogie cars with motors mounted on the trucks, as opposed to the use of independent locomotives.

On the point of tractive effort alone, it stands to reason that greater efficiency should be obtained where every wheel is a driver.

The Reckenzaun accumulator car of 1884 showed in this respect really more advance than others of a recent date, and as a type of vehicle, was well worthy of greater success than it appeared to obtain.

It is, however, useless to say that bogie trucks may be advantageously employed for electric tramcars without looking into the question as to whether such an arrangement is immediately feasible.

The average bogie truck is very like the proverbial chamber where it proved somewhat difficult to swing a cat round in safety; and just as there is a maximum space available for the motor, so also the latter has a minimum size for a given output.

The best proportions of both truck and motor details may be obtained from an examination of standard types. Thus, the ordinary bogie wheel measures, perhaps, 32 inches in diameter. At a normal speed of seven miles per hour, this implies, say, 80 revolutions per minute.

Assuming, for the moment, that there is only room for a single set of gear for reducing the motor speed, this reduction cannot well be less than in the proportion of 1 to 5. With a spur pinion on the motor spindle of 3·7 inches diameter, this should give a large gear wheel on the truck axle of, say, 18·5 inches diam. and a motor speed of 400 revolutions per minute.

An Immisch motor of the S.M. 8 type will give a maximum of 8 brake horse-power at this speed; and its over all dimensions are approximately 4 feet in length, 14 inches in depth and 22 inches in width.

Of course the ultimate decision as to what motors shall be employed must depend upon the condition of the line, gradients, &c., but in most cases it will be found amply sufficient to use, say, one motor (such as that above mentioned) on each bogie truck.

On level parts of the line a single motor would serve to work the car, the other meantime running idle; but both could be used in going up-hill with a heavy load.

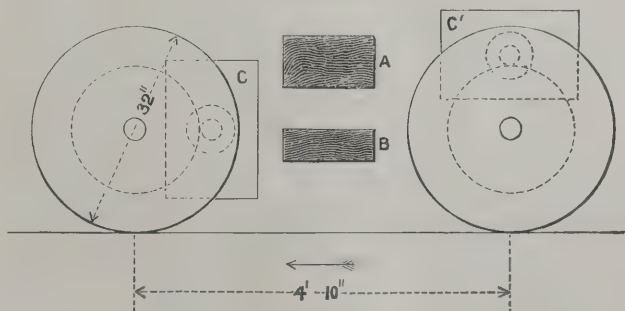


FIG. 1.

This plan allows of the driving truck being, as a rule, in the rear of the car, so that in case the forward wheels should miss the points at a junction and mount the rails, there would be less difficulty in drawing the car back.

Assuming, then, that these various advantages permit of or render advisable two end trucks for the car, and a motor upon each, it is not a very difficult matter to arrive at the amount of space available for motor and gear; and the annexed outline sketch will show what is possible with ordinary designs.

The wheels are of the common size adopted for trucks, viz., 32 inches diameter; and the wheel base is 4 feet 10 inches. At A is represented the spring plank upon which is fixed the pivot plate for the car frame to bear on; this plank goes right across the truck and is therefore shown in section, perhaps rather larger than is usual, but erring on the safe side for strength.

B is the bolster plank, to which are fastened the slide columns; between A and B are placed the powerful springs that give its characteristic easy motion to a bogie car. The plank B also traverses the truck, and therefore the motor and gear must be fixed on either side, not centrally.

C, C', represent the motor (seen endways) in two different hypothetical positions; in either case, of course, it would be supported in the well-known fashion, due originally, it is said, to Mr. F. J. Sprague, that is, with curved extensions from the pole pieces to the truck axle and bolster plank.

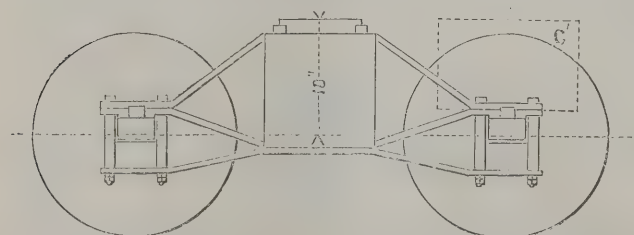
From the former the motor hangs by means of two ordinary bearings, whilst to the latter it is fixed with a double spring connection (tension and compression), so that, whether running backwards or forwards, there is a slight amount of play in the gear, which serves very materially to reduce strains.

It will be noticed that no details whatever of the brake gear have been shown; although these are, of course, very important and essential, they may yet be put aside for the time being until the motor question is decided. When that is done, there will be ample space and opportunity to bring in suitable appliances for braking the car, even if great modification of present designs should be necessary.

In the vertical position of the motor (shown on the left of the sketch) there is plenty of room above, between the motor and car floor, but very little underneath. The bottom of the motor reaches to within six inches of the rail level. In its horizontal position, the top of the motor would in all probability come too near the car floor and frame, unless the design allowed sufficient space for the motor between two adjacent floor stringers (running lengthways of the car), so that the framework might swivel when rounding curves.

Of the two positions, however, the horizontal one seems preferable owing to the greater ease of access; and it is a simple matter to raise the spring plank and pivot plate for the car frame so that the latter may clear the motor.

This implies a little difference in form of the standard diamond truck frame—as shown in the annexed sketch—but the change is merely one of form,



Sketch showing outside frame of bogie truck, with spring plank slightly raised so as to allow the car framework to clear the motor.

FIG. 2.

and does not add in any way to the cost.

By this means a clear space of 18 inches is obtained between the wheel centres and top of spring plank in its normal position; and this space should be sufficient to allow of the motor being fixed in position, as shown at C', above the axle.

As regards the length of motor, a space of 4 feet will more than house it comfortably; and on the usual rail track of 4 feet 8½ inches, there should be no difficulty in securing enough room between the wheels.

In tracing out conclusions from the details thus given, it may fairly be said—

1. That a minimum size has been allowed for the motor.

2. That, consequently, any material increase in the size of car, average load, &c., necessitating the use of a larger motor, will also offer considerable difficulties with respect to the fitting of such a motor upon the standard bogie truck.

3. That only one set of gear has been allowed for; and if a double reduction is desired, the whole design will need considerably modifying.

4. That although it seems a very convenient and simple device to use two motors on each car, there are many drawbacks to such a plan; not only is the first cost greater, but the working expenses also are heavier. Multiplication of machinery is always undesirable. This question, however, deserves separate consideration; there are *pros* and *cons* of importance to be looked into.

5. That it is quite possible to adapt the ordinary four-wheeled bogie truck for use with an electric tramcar, but the task presents considerable difficulties that need the exercise of great care, and it is not so easy as might perhaps at first appear.

## SHALL GAS UNDERTAKINGS SUPPLY ELECTRICITY? YES.\*

By ARTHUR F. GUY, Assoc. M.I.E.E.

THE natural inferences that would be drawn from the above title by gas managers would bear upon the all-important points:—First, what are the objects of so doing? Second, what profits would accrue therefrom?

The first is a question of policy, the second a question of £ s. d. This paper is an attempt to place fairly and concisely before owners of gas property the salient points in each case for their consideration as to the advisability and practicability of gas companies supplying electricity; the tone of the paper, as the title implies, is affirmative.

There are, perhaps, no more powerful organisations in the country than those of gas undertakings, and this is not to be wondered at. Throughout the length and breadth of the land they exist, from the largest cities to the smallest towns. The amount of capital invested in them is enormous. They yield good, and in some cases splendid dividends, and, in short, they are generally in a thriving and prosperous condition. The men who conduct them and have a voice in their proceedings are mostly those of influence and position in the district concerned, and the result is these properties form no small item in a nation's prosperity. The key to all this prosperity is, that they, up to the present time, have had no rival, gas being in universal use.

The general feeling prevalent among gas managers is that the electric light cannot affect gas, and in proof of this they point out the fact that since the electric light has been introduced the consumption of gas has increased. This statement is perfectly true, because artificial illumination is ever on the increase, whether it be by gas, candles, or electricity. Another argument put forward by them is that the electric light is in its infancy. Now this argument must be combated, because the term infancy is applied not only to usage but to the science of electrical engineering. The first point, namely, the "infancy of usage," is, perhaps, correct; but the second is not. We will consider the former first. There are some people who fondly dream that in this miraculous age of invention and discovery some means will come to light whereby any amount of electricity can be collected for next to nothing—in fact, a gift from Dame Nature, such as from some yet undiscovered chemical compound, or some peculiar condition of matter—and consequently that all our present costly and elaborate apparatus for generating elec-

\* Abstract of paper read before the Gas Institute.

tricity will become obsolete. No greater philosopher's stone was ever imagined.

With respect to the electric light being in its infancy as regards use, it is this fact that has shaped the title of the paper, for now is the time for the gas undertakings to act; it will soon be too late, and even now they have lost many a rich prize in the electric lighting line. Companies have been formed all over England to supply electricity, and the pick of the provisional orders have been relegated to either local authorities or private electric companies. This point joins issue with the supreme question, "Shall gas undertakings supply electricity? Yes;" and the reasons that justify this answer will now be given.

Consider the present state of affairs: there is a demand for the electric light; this demand is limited, but in time to come—and no one can say how soon that may be—this demand will be enormous. There are numerous reasons why it would be both politic and advantageous for gas undertakings to supply electricity.

The managing body of a gas works consists of men of great organising and administrative experience. The gas works from long establishment have obtained a certain prestige and influence in the district they supply. A manager knows his customers, and has acquired an insight into the weak and strong points of his district. The connection and vested interests pertaining to the gas suppliers are often numerous and deep-rooted. A gas undertaking has also the great advantage of easily raising capital, at a comparative low rate of interest; whereas new electric companies require financing, and the financing invariably leaves its mark upon them in the shape of a diminished dividend and an abnormally large capital. Many gas companies have large surplus monies in hand which could be invested in running the electric light at a profit to their shareholders. In the laying of electric mains they know exactly the position of their gas pipes, and so there would be none of that friction and petty annoyance that often arise when the electric light company comes on the scene. With regard to the erection of plant, where possible the electric light station should be located in or about the gas works. In some cases, no doubt, there might be a spare corner or outbuilding which might be made to accommodate the requisite machinery. At all events, the expenses incurred need not be so great as where a new site has to be acquired and a new building is specially erected and positioned by an electric light company. A large staff of men are employed at some gas works, some of whom are mechanics, and the assistance which these could render, both in erecting plant and maintaining same, would be of no small value. In the case of an electric light company, such men would have to be especially engaged, and paid at fixed salaries, whether busy or slack. Besides this, most of the office routine might be done by the existing clerical staff of the gas company. This, again, in the case of an electric light company, would mean specially engaged and paid clerks. An electric light company would require a board of directors, general manager, secretary, &c., all of which means a heavy draw upon the dividends, and this matter alone is sufficiently important to turn what might prove a good dividend into a bad one, or even none at all. In the matter of running expenses, there are numerous ways and means whereby a gas manager has the power of curtailing them. For example, the hot coke from the retorts can be utilised in starting the boilers, and some of the bye-products might be used as fuel.

Through being a large consumer of coal for making gas, steam coal ought to be obtained at much cheaper rates. The same refers to the purchasing of other material. The manager knows the best market for certain goods, and through long connection therewith ought to obtain advantageous bargains. The opponents of this paper will probably contend that if a gas works offer all these advantages it proves that it is badly managed, since, if well managed, there should be the strictest economy in everything, and not a man employed except his time be occupied fully, and not a

spare inch of ground in the works but that it has its use. This would be true if the management were perfect, but that point is never reached. No claim has been made that these advantages exist to a large extent, for that would certainly imply waste in the management; but that *some* advantage must be gained from each of these points under consideration cannot be denied.

It is the numerous small savings that in the total make up a respectable sum; however trifling each may appear by itself, when they are all added up at the end of a year it is just possible that they may come to a sum that will turn the balance to the right side of the ledger. It was stated that owners of gas property have great facility of raising capital. Now, with regard to this point, and also the opening up of streets for the purpose of laying electric mains, it is requisite that they obtain the necessary powers first from Parliament and the Board of Trade, and in the furtherance of this they occupy exactly the same position as any private individual or other company (for the second object they must first obtain consent from the local authorities). The same holds true where the owners of gas works are the local authorities.

If the gas companies are desirous of supplying electricity, those who choose should combine to obtain Parliamentary powers authorising them to raise capital and open streets for the supply of electricity, each company, of course, first obtaining the necessary consent of the local authorities.

The number of provisional orders that have been granted since the passing of the Amended Electric Lighting Acts in 1888 has been very great. The majority of these are possessed by private electric companies and the rest by local authorities; as for the owners of gas undertakings, there probably is not one which possesses an order, excepting Bradford Corporation.

Attention may be directed to America, where there are quite 100 gas companies supplying electricity in connection with the Thomson-Houston system alone. How many are supplying electricity by other systems is not known exactly, but they must come to a large number. And to show that electric light industries pay, it may be stated that the Thomson-Houston Company has invested in them £10,000,000 sterling, and each plant on an average throughout may be taken to be worth £20,000. Some pay 18 to 20 per cent., others less, and on the whole the average is 4 per cent. on the total capital; but it must be remembered that 25 per cent. of these stations are in their first year, and therefore as yet they have paid no dividend, because they are just starting. Taunton Electric Light Company paid 5 per cent. first year, 6 per cent. second year, 5 per cent. third year.

If a gas undertaking wishes to take up the supply of electricity, what they should do in the first place is to obtain the services of a competent electrical engineer, and let him advise them as to the cost and system to be employed.

If things continue like this, where will the gas company be in a few years' time? They will have in every district where there are gas works an electric light company competing with them, and then they will see that it would have been well if they had obtained a footing themselves. Assuming gas companies supply electricity, and looking into the far future, who knows but that gas works will eventually become electric light works, and that as the electric light enters into universal use, so will gas die out?

A comparison of cost between gas and electricity will now be made. The ordinary gas jet in private houses may be taken to give about 14 actual candle-power, burning 5 c. ft. of gas per hour. Let the price of gas be, say, 3s. per 1,000 c. ft. The cost of 5 c. ft. would be .18 of a penny for 14 candle-power, and for 1 candle-power the cost would be .013 of a penny per hour. Now, take the case of electricity. Assume that the price is 7½d. per unit. A unit signifies 1,000 watt-hours. An incandescent lamp of 16 actual candle-power absorb 56 watts; that is, 3.5 watts per candle-

power; and the cost of this is 1·40th or ·025th of a penny for 1 candle-power per hour.

This is for the supply of electricity alone. The cost of the lamp must now be considered. The lamp may be taken to last 1,000 hours, and costs 3s. 9d. Therefore the cost of 1 candle-power per hour will be ·0028 of a penny;

Hence total cost is...     ...     ·0250  
   ·0028

·0278 of a penny.

Therefore, gas costs ·013 of a penny per candle-power per hour; electricity, ·0278 of a penny per candle-power per hour. So that with gas at 3s. per 1,000 c. ft. and electricity at 7½d. per unit, the cost of the latter is little more than double that of gas, or, say, 6s. 2d. for an equivalent amount of light.

The following table gives the equivalent cost of gas for different prices of electricity per unit:—

Pence.

Per unit of electricity ...	4	4½	5	5½	6	6½	7	7½
Per 1,000 cubic feet of gas	41	46	51	56	61	66	71	76

Pence.

Per unit of electricity	8	8½	9	9½	10	10½	11	11½	12
Per 1,000 c. ft. of gas	81	86	91	96	101	104	110	115	120

The above is for incandescent lamps, not arcs. From the above table it will be seen that the approximately equivalent cost of gas is obtained by multiplying the price per unit by 10. Also, that every rise of ½d. per unit of electricity means a rise of 5d. per 1,000 c. ft. of gas. The price adopted in London is 7½d. per unit, or equivalent to 6s. per 1,000 c. ft. of gas. Gas works which supply electricity ought to be able to do it at 6d. per unit, and there are numerous towns in England where 5s. per 1,000 prevails for gas. This is bringing the price down in these cases on a par with gas. The gas committee of the Bradford Corporation supply at 5d. per unit, equivalent to 4s. 3d. for gas, and have a separate station for electric lighting. Local authorities, whether they possess gasworks or not, ought to be able to supply at this rate, so that when it comes to be a question of general adoption, and local boards throughout the country begin to establish central stations, there is this fact prominently before gas people, that the electric light can be supplied at equivalent cost of 4s. 3d. for gas. This is a price not out of the way, and certainly cannot be called expensive or high; and numbers will be glad to have it at this price for the sake of its superior illuminating power. Where great intensity of light is required, arc lamps afford a very cheap illumination; and for equal light with gas, its equivalent cost for gas would be only about 1s. 8d. per 1,000, or, roughly, the arc lamp costs only about half that of gas for the same amount of light—taking gas at 3s. per 1,000 c. feet., and electricity at 7½d. per unit. The reason of this is that for the same amount of electric energy the intensity of light emitted from an arc is about four or five times that from an incandescent lamp.

Before closing this paper, a few items will be given concerning the cost of installing plant. Take the case of a plant for 2,000 incandescent lamps, run by high tension alternating current dynamos and transformers, the wires being overhead, and supplying six miles of route. The total cost of putting down this plant, in the precincts of a gas works where a building could be appropriated, would be about £8,000 or £4 per lamp. It is found that on an average only two-thirds of the lamps installed in any premises are alight simultaneously; therefore, a capacity for 2,000 lamps means 3,000 installed in houses. To assume that each lamp installed is alight for 800 hours per annum is very

moderate. This, then, equals the full load, or 2,000 lamps for 1,200 hours. 800 per hour signifies a lamp burning from dusk to a trifle after 8 p.m. every day throughout the year.

2,000 lamps for 1,200 hours consume  
2,000 × 1,200 × 56  
= 134,400,000 watts  
= 134,400 units

and at 6d. per unit this equals £3,360.

The total working expenses, including 7 per cent. for depreciation of plant, would not come to more than 4½d. per unit, or £2,520. With a revenue of £3,360, this signifies profit of £840, yielding a dividend of 10½ per cent.

That the above is practicable may be proved by stating that the Electric Company at Rochester supplies electricity at 6d. per unit, and can pay a dividend of 11 per cent.

## FIRE IN AN ELECTRIC LIGHT STATION.

AT 9.15 o'clock p.m., on Wednesday, the 11th inst., the central electric lighting station of the Manhattan Electric Light Company, located at the corner of Eightieth Street and Avenue B, in New York, was struck by lightning and very heavily damaged by fire. The lightning did not strike one of the company's circuits and come into the building over the wires, says the *Electrical World*, for in that case the bolt would have gone to earth through the lightning arresters placed upon the lines, but it struck the roof of the building itself and originated the fire directly underneath the tower through which the wires enter, and at the top of the incandescent light switchboard, and from this point the flames spread rapidly throughout the building wherever there was any combustible material to be consumed.

The equipment of this station was of an excellent quality, the building itself being of brick, with fire-proof floors and partition walls, although the tower furnished a passage-way for the flames from the first to the second story. Customers using about 20,000 incandescent lights were supplied from 18 Slaterry alternating current dynamos, while the arc lights were run from 11 machines of the Brush and Thomson-Houston types. The two switchboards, one for the arc lighting circuits and the other for the incandescent lighting, although near together, were kept entirely separate. Between them was a new and nicely furnished gallery, which had just been fitted up for the regulating devices of the incandescent circuits. The floor above the dynamo room was occupied by the offices and store rooms of the company, while upon the floor beneath was the engine room. This contained four 750 horse-power compound condensing engines, and two 350 horse-power high-pressure condensing.

The damage done was confined to the dynamo room and the offices and store rooms, as the fire did not reach either the engine or boiler rooms. Out of about 30 machines only two or three of the arc dynamos, that were located furthest from the origin of the fire, escaped such serious injury as to make them unfit for use. The 18 Slaterry dynamos sustained an average damage of perhaps \$1,500 each, although it is difficult to tell just what the damage will be until the machines are put into the shop and overhauled. The arc light dynamos, being further from the burning switchboards, were not so seriously damaged, although they were considerably injured by water. The incandescent circuit switchboard, together with 280 switches, 64 ammeters and about 70 voltmeters, was entirely destroyed. Fifteen compensators, 18 rheostats, and many other accessories were rendered worthless. The arc light switchboard, with its bank of switches, was partially consumed, and will have to be rebuilt and refitted. Every belt in the station was so badly burned as to require an entirely new outfit. Of the four large 48-inch engine belts, only one remained that could be repaired so as to be fit for use. Considerable damage was sustained upon the

stock, and upon the books, prints and drawings kept in the office of the engineering department.

The work of reconstruction and recuperation was begun at once after the fire, and the manner in which this has been done, and the rapidity with which the plant has been again put into running order, reflects great credit upon the management of the station, and is an illustration of the marvellous capabilities of a well-planned system of electric lighting. The night after the fire about one-half of the arc lights and 12,000 incandescents were supplied with current as usual, while on the second night 17,000 incandescents were connected, and on the third night not far from 20,000 lights. The company was able to make this fine showing through the kind assistance of its very obliging business rivals. Many of its lighting circuits, of which it has nineteen in all, were connected to other stations in the city, and have since been supplied by current from these stations. Meanwhile the company has been putting its own plant in running order. Five new Slaterry dynamos were received soon after the fire from Ft. Wayne, Ind., by express, and other machines were sent for and received from the Thomson-Houston factory at Lynn, Mass., while the electric lighting companies in New York have very kindly loaned such machines as could be spared from their own equipment. By these various means the company has been enabled to replace in less than a week at least two-thirds of its entire plant, although, of course, this hasty installation has necessitated much work of a merely temporary character. When it is considered that the entire plant, with the exception of the engines, boilers and shafting, was rendered useless until replaced by new machinery, it must be admitted that the results obtained in so short a time reflect great credit upon Mr. E. A. Leslie, the general manager of the company, to whose energetic action much of the wonderful recuperation of the damaged plant is due.

#### COST OF ACCUMULATOR TRACTION.

AT the annual meeting of the Tramways Institute of Great Britain and Ireland, to which we briefly referred last week, several papers were read and discussed. The reading of papers before the Institute was a welcome innovation, as none had been introduced at previous meetings. It is, however, only to three of these that we need refer. The first was descriptive of the Birmingham cable tramway, and the only interesting facts elicited were that the initial cost of a single line one mile long ranged from £10,000 to £15,000, a double line of the same length, £25,000; and that the cost of working per car mile was 8½d. for a car carrying 70 passengers. As compared with horse traction, which averages 6½d. per car mile throughout the United Kingdom for cars accommodating 52 passengers, the cost for cable haulage is slightly greater.

The other two papers treated of electric traction. One of these was a mere recapitulation of the different systems and numbers of electric tram and railways in operation in the United States, the information being mainly derived from monthly magazines. The other paper, by Mr. A. Dickenson, C.E., of Birmingham, referred principally to electric traction in Europe. The author referred to the Julien system of electric traction—whatever that may be—and gave a detailed description of the accumulator cars shortly to be introduced on the Bristol Road route of the Birmingham Central Tramways Company. Turning to the Barking electric tram-cars worked by the (now) General Electric Power and Traction Company, Limited, at a contract price of 4½d. per car mile, he stated that if the whole of the tramways in the United Kingdom had been worked last year at that figure the result would have been a saving of

£200,000! The speaker, in conclusion, asserted that the Barking line had resulted in a small profit to the contractors.

The discussion on the two traction papers was taken together. Mr. A. Willbond asked for the authority for the statement that the Barking cars were a commercial success. The reply from Mr. Dickenson was that he was authorised by letter from Mr. R. Macpherson, one of the directors of the contracting company, to state that such was the case. Mr. Willbond then said that he would produce Mr. Macpherson's own figures, which showed conclusively that the line was a failure from a commercial point of view. This brought forth more than one protest from Mr. Dickenson, but it having been put to the members of the institute, who evidently not only relished the idea of the statement being contradicted, but who also desired not to be gulled on the subject, the speaker was permitted to proceed. He stated that from the opening of the line on the 14th June to the end of December last year, the total mileage attained by the cars was 34,366 miles, and that the total amount of profit made during that period, according to balance sheets shown to him by Mr. Macpherson, did not exceed £70. This sum of about £70 was realised after paying drivers' wages, expenses at charging station, including coal, oil and water, but exclusive of the engineer's salary. It, however, excluded one of the most important points in electric traction, namely, the cost of accumulator renewals. According to the generally admitted cost of renewing the accumulator plates, that is, from 1d. to 1½d. per car mile, or an average of 1¼d., the cars must have been worked by the contractors at a loss. Taking the actual mileage of 34,366 miles and multiplying this by 1¼d., the cost for renewals alone, without allowing anything for the depreciation of motors, gearing and for station plant, amounted to £178 19s. 9d. This showed, continued the speaker, a loss for the first 6½ months' operations of £108 19s. 9d. Therefore, the cost per car mile was 5¼d. without considering the expenses previously mentioned.

Several other gentlemen took part in the discussion, which was of a lively character. Mr. Dickenson again protested that Mr. Macpherson had given him authority to make his statement regarding the Barking cars, but he appeared to be under the delusion that two individuals could not know anything about the same subject. The president, Mr. Carruthers-Wain, said, however, that Mr. Willbond's assertions as to the commercial failure might probably not apply to the half year just ended, and that *possibly* the statement of Mr. Dickenson did so apply.

Mr. Joseph Smith, the chairman of the Birmingham Central Tramways Company, and upon one of whose lines the previously mentioned accumulator cars will shortly commence service, laid great stress upon the cost of generating the current, and stated that time only would show the *actual cost* of accumulator traction per car mile. He hoped at next year's meeting of the Institute to be able to lay before the members data concerning the actual working cost of the self-contained cars, which were to do service on one of his company's lines. Mr. Smith's remarks were well received, and the consensus of opinion seemed to be that accumulator traction at present was not commercially successful.

To the above we may add that if the Barking line is a paying concern, why did not the contractors send a qualified representative with *bonâ fide* data showing that such was the case instead of authorising one gentleman to make the assertion—which he could not prove—that the running of the cars had resulted in a small profit. Again, in addition to the data furnished by Mr. Willbond, there must be considered the salaries of the secretary and clerk, office expenses, interest on capital outlay, &c. Moreover, as a fresh set of plates were supplied for the batteries during April—May, the cost of these would at their then market price amount to over £1,000. We have, therefore, no reason for thinking otherwise than that the Barking line so far is a failure from a commercial aspect.

A SYNTHETIC STUDY OF DYNAMO  
MACHINES.*Continued from page 638.)*

## VIII.—ARMATURE REACTIONS—(continued).

IN section VI. we saw that the E.M.F. of any machine was expressed by the equation

$$E = \frac{N s W}{10^8},$$

where  $N$  is the number of lines of force passing into the armature core from each pole-piece;  $s$  the number of revolutions per second, and  $W$  the conductors on the exterior. This is true for multipolar machines if the armature is coupled up in as many parallels as there are poles, and the output, multiplying by  $C$  is, therefore:

$$E C = \frac{N s W C}{10^8}. \quad (7)$$

In our last article we observed that it was more convenient to express the load on the armature by the volume of current it carries, this being the product of the conductors on the exterior, and the current in each.

The volume is equal to  $\frac{W C}{p}$ ; whence substituting for  $W C$  its value, we have, in terms of the volume  $V$ , the output:

$$E C = \frac{N s V p}{10^8}, \quad (8)$$

$p$  being, as before, the number of poles. We have now two expressions which we shall find most convenient to apply to the design of machines. We have first the volume, which is expressed in terms of the induction in the air gap and the gap dimensions, and, secondly, the output given in terms of the volume, number of poles, and other dimensions. Without fixing for the moment these latter, we may say that the considerations which determine the output, so far as the armature is concerned, are known, but before the magnetising force required to produce the requisite induction in the air gap can be ascertained, it is necessary for us to consider the component of the armature windings, weakening the field.

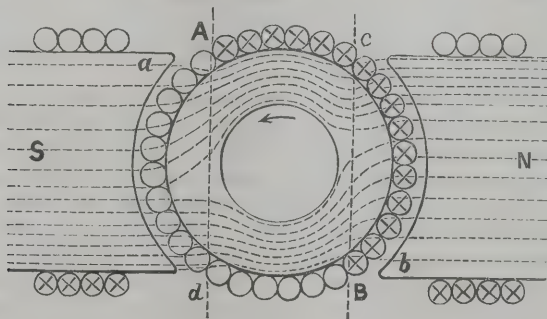


FIG. 148.

The brushes being placed at A and B, fig. 148, we have seen that the convolutions lying between the two vertical lines, A  $d$  and  $c$  B, directly oppose the forward induction, as they form a belt of conductors having a width equal to twice the angle of lead, in which the current flows in an opposite direction to the current round the magnets. If  $A_2$  be the ampère turns on the armature, and  $\lambda$  the angle of lead, the ampère turns weakening the field are  $\frac{4 \lambda A_2}{360}$ , or calling  $W$  as before, the conductors counted all round the exterior, and  $C$  the total current, there are on the armature producing this effect  $\frac{2 \lambda W}{360}$  turns of wire, carrying a current of  $\frac{C}{2}$  ampères. This is the same as if there were wrapped

round the armature, in a plane perpendicular to the direction of the field,  $\frac{\lambda W}{360}$  turns of a conductor,

having flowing in it, but in an opposite direction to the current in a field coils,  $C$  ampères, or the same current as carried by the armature. The demagnetising force in ampère turns is thus  $\frac{\lambda W C}{360}$ . In this expression the lead,  $\lambda$ , is assumed to be known, though, as already mentioned, its exact predetermination is a matter of some doubt.

In order to compensate the weakening of the field, the magnetising force on the magnets must be, according to this equation, increased by an amount equal to  $\frac{\lambda W C}{360}$  ampère turns. We have had no opportunity of

testing, experimentally, the accuracy of the expression, but so far as judgment can be given from what has been already done, this formula always gives a value for the ampère turns too low. It seems that the problem does not admit of such simplicity of treatment as here assumed, or probably other reactions are combined with the one in question, making it impossible to estimate accurately the effect produced by each. As regards drum armatures, Prof. Thompson remarks that a very convenient approximation to the back induction of the armature may be made by simply counting the number of armature conductors exposed between the horns of the polar surfaces, and multiplying this by half the armature current. He further explains that the nearness of this assumption arises from the fact that in most modern dynamos, for all currents, the point for the brush is at a position not far from that corresponding to the passage of the commutated section from the idle space between the pole pieces into the working space in the polar gap. According to this statement, the angle between the pole tips is  $2 \lambda$ , and the conductors between the tips are  $\frac{2 \lambda W}{360}$  which, multiplied by the half current, gives  $\frac{\lambda W C}{360}$ , the expression before obtained. On the occasion

on which Prof. Thompson made the above statement Dr. J. Hopkinson observed that, so far as he knew, the lead of the brushes in the best machines was never so large, and that the brushes were consequently behind the polar horns. The two statements appear difficult to reconcile, but if we take both as representing facts, omitting the explanation attempted by the former speaker, we come to this, that since the angle of lead is always less than half the angle between the tips, the formula gives too low a value, seeing that to obtain the actual ampère turns required for compensation we have to assume the lead to be greater than it really is. Doubtless, makers of dynamos have rules of their own for the compensating ampère turns to be added to the magnets; but very little in the way of experimental evidence on this point has been published, and the dearth of figures concerning a matter so important is much to be regretted. On the subject of drum armatures we have no evidence whatever, and very little regarding cylinders. Last February Prof. Ayrton made some tests on a Manchester dynamo, the results of which afford us a little information. This machine had 320 conductors on its armature, which carried a current of 31 ampères. The angle embraced by the pole pieces was presumably  $140^\circ$ , and we will assume that the lead was  $20^\circ$ , which would bring the brush just under the pole tip. Under these circumstances our formula would give for the magnetising force to com-

pensate the back induction  $\frac{20 \times 320 \times 31}{360} = 550$  am-

pères turns, whereas the value of the compensating ampère turns actually required was 1,200. In June, 1888, Mr. Esson made some experiments on a Phoenix dynamo, in which the weakening effect due to the armature was also observed. The armature of the machine tested carried a current of 92 ampères, and

had wound on it 180 conductors. The angle embraced by the pole piece was short, being only  $112^\circ$ . The lead of the brushes we will assume to have been  $30^\circ$ , though Mr. Esson thinks it was less than this; it was certainly not more. Under these circumstances the ampère turns required for compensation, as given by the formula, would be  $\frac{30 \times 180 \times 92}{360} = 1,380$ , but ex-

periment showed that the extra magnetising force required was 2,610. The method of conducting these experiments is to run the machine at a constant speed, while having some arrangement by which the exciting current can be easily varied and accurately measured. The difference between the ampère turns required on the magnets when the machine is running without current in the armature, the brushes being on the no-load line, and those required when the full current flows and the brushes are adjusted to their non-sparking point gives, the E.M.F. being in both cases the same, the magnetising force required for compensation. These are the only experiments of which we know referring to this question.

It is apparent, then, that a very considerable discrepancy has to be accounted for. Probably it is much less in drum than in cylinder machines, but for the latter it appears that there must be allowed about twice as many ampère turns for compensation as the formula indicates. This shows that the formula is not complete, that there are in fact factors omitted which considerably modify the results. In the absence of complete data the ampère turns necessary have to be determined experimentally by the makers for the different designs they manufacture. For the Phoenix machines the ampère turns which have to be added to the magnets to compensate the weakening are given by Mr. Esson as '66 of the ampère turns on the armature. This is probably a fairly approximate coefficient for other Gramme wound machines

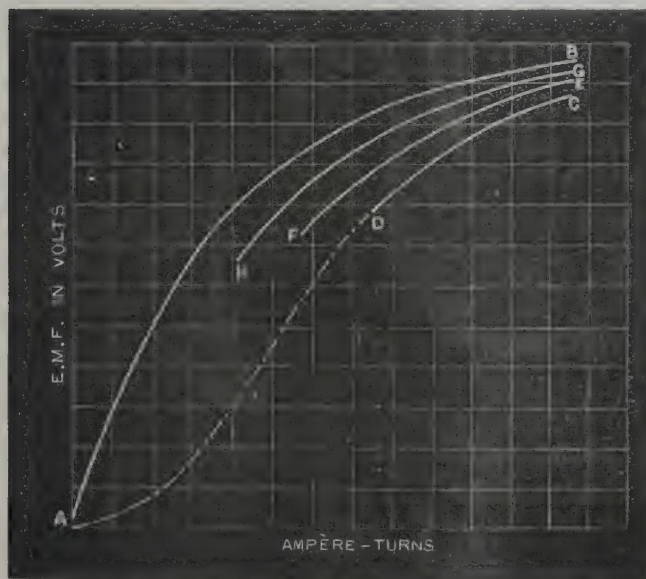


FIG. 149.

The weakening effect of the armature on the field may be conveniently recorded for any particular machine by a series of curves, as shown in fig. 149. The machine is run at a constant speed, and the field magnets separately excited to determine the relation between the magnetising force and the induced E.M.F. In the figure the former is represented by abscissæ and the latter by ordinates, the curve, A, B, being obtained while running without a current in the armature. The curve, C, D, is obtained when there flows in the armature the greatest permissible current, this being kept constant while the strength of the field is varied and the brushes adjusted to the sparkless position for each reading. The curve stops at D, because with a farther weakening of the field a non-sparking position cannot be obtained, and a less E.M.F. for that

particular armature load and speed becomes impracticable. If, in spite of the sparking, the observations were continued with a gradually diminishing strength of field a continuation of the curve, as shown by the light dotted line, D, A, would be obtained. The curve, E, F, is obtained with a less armature load, and G, H with the load still further reduced. It will be observed that as the ampère turns on the armature get less the curve can be carried lower, or, in other words, the field can be weakened down to a greater extent before we arrive at the sparking point. From this diagram we learn everything which requires to be known respecting the magnetic circuit of the particular machine from which the results it represents are obtained. It tells us the ampère-turns required for any induction on open circuit, and how many ampère-turns must be added to compensate the armature reaction, or how many will be required to raise the E.M.F. by a required amount with any current flowing. That the ampère turns required to compensate the load are fairly constant for all values of the induction will be apparent.

In determining the magnetising force required for multipolar machines, we found it often advisable to ascertain the ampère-turns required for each individual field coil, considering the induction which had to be produced, and the lengths of the several components of that part of the magnetic circuit through which each coil had to force it. As in finding the magnetising force on the assumption of no armature reactions, this treatment was most convenient, so in dealing with the armature reactions it is found most convenient to determine the ampère-turns which are required for each pole to compensate the weakening effect, the ampère turns for each coil being then ascertained accordingly as the field is of the single or divided circuit class, and as there are one or two magnetising coils on each circuit. It will be remembered that in the divided class of field the induction from each pole takes a double path through parallels of magnetising coils, while in the single class, though the induction may take two paths, these are combined in one where the coils are, so that the whole of the lines from the pole pass through each coil. Whether the machine is bipolar or multipolar the compensating turns have to be determined experimentally—our object at the moment being to show that their value is determined by similar considerations and that the allowance for machines having four or more poles may be easily deduced from that provided for machines with two poles.

The ampère turns on the armature, by which each pole is directly influenced are found by dividing total volume of current the armature carries by the number of poles. As mentioned in our last article, we may imagine the conductors to be replaced by a cylinder of copper divided at the brushes into as many segments as there are poles, the sheet of current in each producing a direct effect upon its corresponding pole. The effect is seen first in the distortion or twisting of the field; secondly, in the weakening. On the assumption that the brushes are close to the tips, it will be remembered that all the conductors under the pole piece are concerned in producing the distortion, while those lying in the space between the tips of the adjacent poles produce the weakening. In the two-pole machine we saw that the magnetising force producing the back induction was  $\frac{\lambda W C}{360}$ , or for each pole

$$\frac{\lambda}{360} \times \frac{W C}{p}, \text{ where } p \text{ is the number of poles. But in}$$

terms of our previous definition,  $\frac{W C}{p} = v$ , the volume which is carried by the armature, and we get, therefore, as a final result for the ampère turns demagnetising each pole,  $\frac{\lambda v}{360}$ , this expression being in terms of the volume, and like previous ones, independent of the number of poles.

It is probable that in multipolar machines the dis-

crepancy between the ampère turns which have to be added for each pole piece, and the number indicated by the formula is as great as in machines having two poles. Twice as many may be required in this case as in the other, and as already observed, farther information on the subject is much needed. Until this is forthcoming, however, it is sufficient to have shown that the same *kind* of expression is true for all types of machine.

(To be continued.)

## EDINBURGH EXHIBITION.

### EXHIBITS.

(Continued from page 722, Vol. XXVI.).

No. 59. Messrs. Paterson and Cooper exhibit a good assortment of dynamo machines, arc lamps, measuring instruments, and general electric light fittings. This

signed for ship work. For saloons and cabins the lamp brackets and pendants are silver plated and of artistic design, while for deck and cargo work, fittings of a very strong design are employed suited to the rough work for which they are intended. The portable cargo lantern has a cluster of three 16-C.P. lamps, and is provided with a strong outer guard for protection; the hold lamp fitting is made of heavy iron, and has hinged to it a strong shutter, so that when closed up cargo can be placed in the hold against it without fear of its being damaged. In ordinary cases these lamps are only used in port when loading or discharging cargo, but should the hold be used for cattle or sheep they are very serviceable at sea. The regulation types of mast and side lamps fitted electrically are shown, each having two 16-C.P. lamps. It is claimed that the light is visible at a greater distance and clearer than that from oil lamps; also that in stormy weather they will burn perfectly steady when it would be difficult to keep oil lamps burning. Another appliance used in connection with ship work and shown at this stand is a small motor fan or saloon punkah. These have been applied

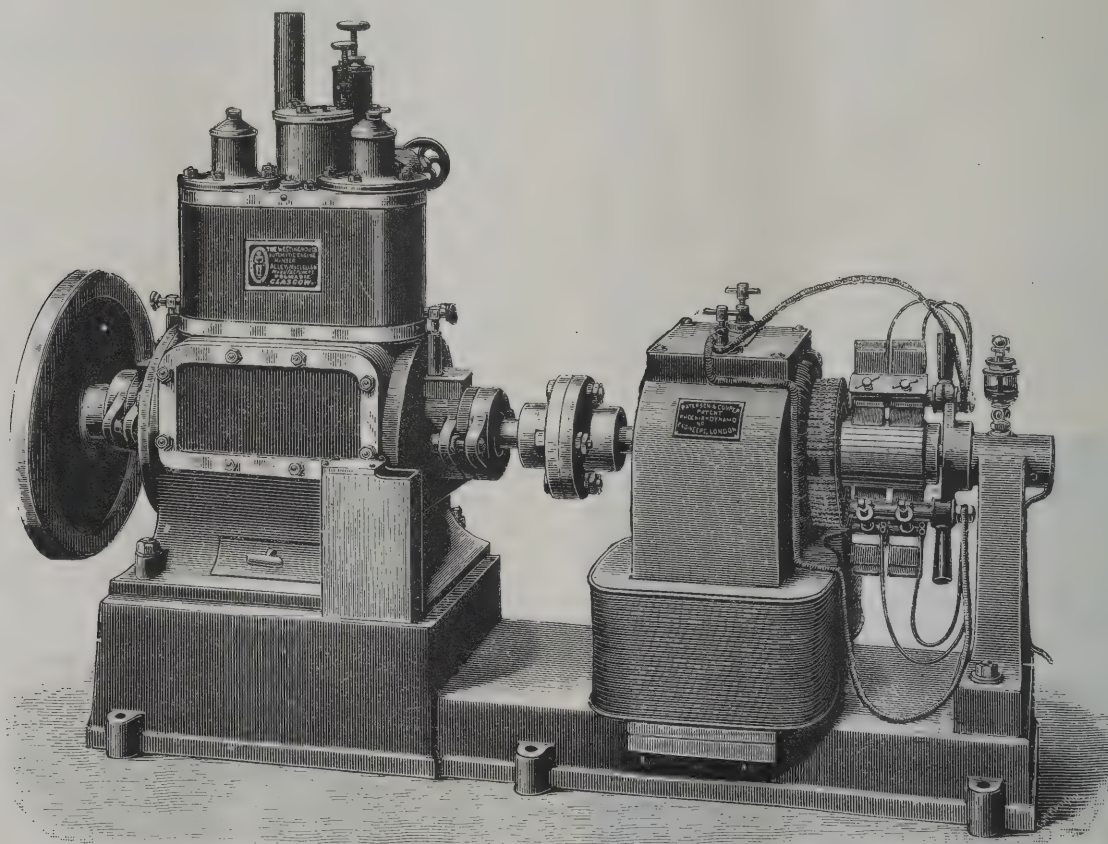


FIG. 1.—PHOENIX DYNAMO AND WESTINGHOUSE SPECIAL ENGINE.

firm's standard pattern of single magnet Phoenix dynamos is well known, and has been described in our columns on previous occasions. Different sizes are shown, suitable for belt or rope driving, and in addition is exhibited a Phoenix dynamo coupled direct to a "Westinghouse Special" engine, particularly suited for ship lighting or for employment where the saving of space is an object. This combination is shown in fig. 1, the cast iron bed plate which supports the engine taking the place of the usual machine bed, and forming, as does the latter, the yoke to the magnet. At a speed of 600 revolutions per minute the dynamo gives 45 ampères and 100 volts, furnishing power sufficient for 75 lamps of 16 C.P. each. The engine works at a steam pressure of 100—120 lbs. per square inch, and the speed is automatically governed. The cylinders are  $4\frac{1}{2}$  inches in diameter, and the stroke 4 inches.

Amongst their electric lighting accessories are to be seen polished slate distribution tablets, for ship work, fitted with ammeter and voltmeter, fuses, and spring switches labelled with the names of the various circuits; also a large number of fittings specially de-

signed for ship work. For saloons and cabins the lamp brackets and pendants are silver plated and of artistic design, while for deck and cargo work, fittings of a very strong design are employed suited to the rough work for which they are intended. The portable cargo lantern has a cluster of three 16-C.P. lamps, and is provided with a strong outer guard for protection; the hold lamp fitting is made of heavy iron, and has hinged to it a strong shutter, so that when closed up cargo can be placed in the hold against it without fear of its being damaged. In ordinary cases these lamps are only used in port when loading or discharging cargo, but should the hold be used for cattle or sheep they are very serviceable at sea. The regulation types of mast and side lamps fitted electrically are shown, each having two 16-C.P. lamps. It is claimed that the light is visible at a greater distance and clearer than that from oil lamps; also that in stormy weather they will burn perfectly steady when it would be difficult to keep oil lamps burning. Another appliance used in connection with ship work and shown at this stand is a small motor fan or saloon punkah. These have been applied

to several of the eastern-going ships, fitted by Messrs. Paterson and Cooper, and the cool atmosphere provided by their use has added much to the comfort of the passengers. The fan attached to a small electro-motor is placed near the end of the saloon, and furnishes a continuous supply of cool air, a switch for turning the driving current on or off being conveniently situated under the control of the steward. Models of several of the steamers which Messrs. Paterson and Cooper have fitted with electric light are shown. Amongst these is the ss. *Parisian*, a handsome vessel, 440 feet in length, built for the Allan Line Mail Service by Napier and Sons, of Glasgow, in 1881. Her carrying capacity is 9,663 tons, and her engines are of 6,000 horse-power. She is fitted with 500 electric lamps, the current being supplied by two Phoenix dynamos, each belt driven from a separate high speed vertical engine. Another model shown is that of the ss. *Perth*, the fourth vessel fitted by Paterson and Cooper for the Dundee, Perth and London Shipping Company. This vessel has just been completed by the builders, Messrs. W. B. Thompson & Co., of Dundee,

and, in addition to the ordinary lights for the cabins and passenger service, special fixed lights are provided for the cargo work in the holds and on decks. In addition to the models several photographs of the steamers fitted by the firm are also on view.

The Phoenix arc lamp, manufactured by the firm, has a place at the stand, and is shown with its protecting cover removed in fig. 2. This lamp is of the differentially wound class, and is equally well adapted for burning in series on a constant current circuit or in parallel on a constant potential circuit. In the drawing, A represents an electro-magnet wound with coarse and fine wire coils, the pole pieces, P, acting upon an armature, K, fastened upon a frame, H, D, pivoted at F. The frame carries a brake wheel, B, on

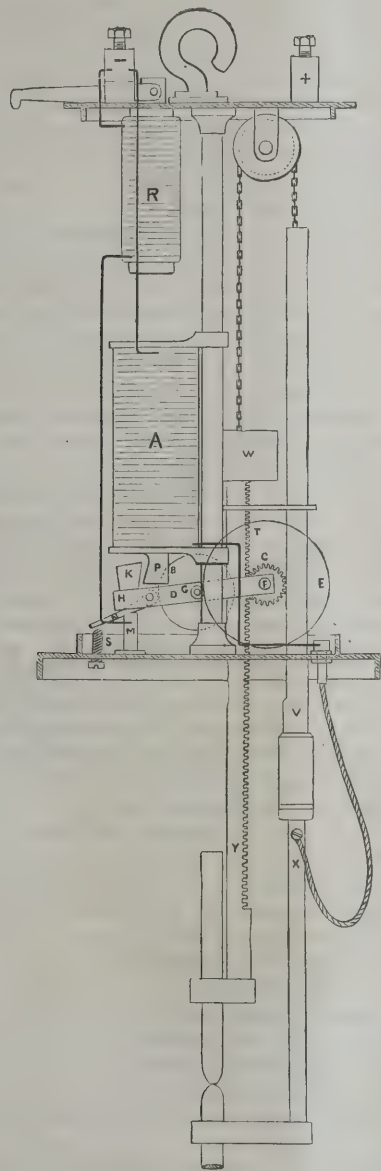


FIG. 2.—PHOENIX ARC LAMP.

the axle of which is fastened a small pinion, G, and a brake lever, N, made to grip B by a helical spring attached to the frame. The pinion, G, gears into the larger toothed wheel, E, on the axis of which is a pinion, C, engaging with the rack, Y, of the positive carbon rod. This rod carries a weight, W, which in descending enables the negative rod, V, X, to be lifted. When no current is flowing the brake lever, N, rests on the screw, S, which releases the brake wheel and allows the carbons to come into contact. The action of the lamp is as follows:—The current enters the right hand positive terminal, passes through the framework of the lamp to the rod, Y, and thence to the positive carbon. It returns by the insulated rod, X, and flexible cord attached to it, passing through the coarse wire coils on A, and then to the negative terminal.

The magnet attracts K, raising the frame, H, D, this causing the lever, N, to grip the brake wheel, and the toothed wheels, E and C, turning, the rod Y, is lifted, and X lowered, the arc being thus formed. As the carbons consume the difference of potentials at the lamp terminals rises, the current in the fine wire coils round A, which are a shunt to the terminals, consequently increasing. This weakens the electro-magnet, A, and allows the frame, H, D, to fall gradually, and the carbons to approach each other. When the lever, N, comes in contact with the screw, S, the brake is released, allowing the carbons to approach as the consumption continues. While the lamp is burning the end of the lever remains quite close to the screw. If the carbons burn out, or from any other cause the circuit through them is broken, the frame, H, D, drops on the insulated pillar, M; this completes the circuit from the lamp frame through the German silver resistance, R, to the negative terminal, thus preventing a break in the continuity of the circuit when the lamps are in series. When burning in parallel on a 65-volt circuit, the bye-pass resistance, R, is removed. The pole-pieces, P, and armature, K, are shaped so that for the same current and difference of potentials the pull on the frame is in every position similar, but should the current or difference of potentials alter, a small movement of the frame at once adjusts the arc to its normal length. A dash pot attached to the armature checks any sudden movement due to impurities in the carbons, &c. These lamps are installed at Peter Robinson's, Oxford Street, and Regent Street houses, at the Albert Institute, Dundee, and in many other important installations.

A variety of electrical measurement instruments, for which the firm has justly a reputation, is, of course, exhibited. Among these are the well known permanent magnet Ayrton and Perry instruments, which the firm has manufactured since their first appearance, and which still find a good sale. Several Phoenix dead-beat electro magnet ammeters and voltmeters are also shown, the controlling force in these being furnished by a strong spring instead of by the weak directional effort of an electro-magnet with a very small core. These instruments are made to measure currents up to 2,500 ampères. Cardew voltmeters of the latest pattern, as well as all forms of instruments used for electric light testing, are to be seen.

A model of a new system of railway carriage construction, designed by Mr. R. M. Short, is shown, the carriage containing first, second, and third class compartments, with lavatories, &c., electrically lighted. Though not in connection with electricity, Messrs. Paterson and Cooper have a model on view of Captain Anderson's patent hold-handy ladder, which is designed to supersede the dangerous hold ladder now in use. It affords easy access to the holds, and is of great convenience to shipowners and surveyors, when inspecting cargo, &c. The ladder is fitted on the ss. *City of Vienna*, and other steamers of the City Line.

## OBITUARY.

### JOHN BOURDEAUX.

IT is with great regret that we record the death of Mr. John Bourdeaux, submarine superintendent of the postal telegraphs on Her Majesty's telegraph cable ship, *The Lady Carmichael*, stationed at Dover. He died on Wednesday, the 2nd instant, at 8.0 a.m. Born in 1834 he had just completed his 56th year. Mr. Bourdeaux joined the Electric Telegraph Company when 15 years old, in the early days of telegraphy, and after two years' service with them joined the Submarine Telegraph Company. He went to Dover in 1862, and was submarine superintendent for the laying and repair of the English Channel and North Sea cables for nearly 30 years. Mr. Bourdeaux had a busy and anxious time in connection with the

transfer of the Submarine Company's business and plant to the Post Office. He had the double difficulty of looking after the interests of his old employers, and of making friends with the new ones; and, in assessing the value of cables, whose life and condition was extremely varied, much tact and diplomacy was required. During the tests taken immediately before the transfer Mr. Bourdeaux's health began to fail; and, though nominally in the Postal Service, he really performed but little duty since April, 1889. He was of a very genial disposition, with excellent conversational ability, and his general cheerfulness did so much to relieve the monotony of weather-bound cable operations that his absence will be exceptionally felt. He leaves a widow and 14 children.

### ELECTRICAL SECTION, LONDON CHAMBER OF COMMERCE.

THE river excursion of this section of the London Chamber of Commerce took place last Saturday under somewhat unfavourable conditions. The night previous had been very stormy, and the wind and rain were still in evidence on the river, as in London, when the time for the start arrived. The applications for tickets originally numbered 55, but owing to some delay in settling the programme, &c., that number dwindled down to 44, and of these, only 22 put in an appearance at Windsor, from whence the electric launch was to take them to Henley. Some little surprise was felt when it was found that neither Mr. Trotter, who had been responsible for some of the arrangements, nor Mr. Kenric Murray, whose name had appeared to some of the notices issued, was present when the last trains arrived respectively from Paddington and Waterloo; but this surprise became as nothing when it was found that the General Electric Power and Traction Company's electric launch, the *Viscountess Bury*, which had been engaged for the occasion, was not forthcoming. Some petty excuse was suggested about a dynamo (presumably at the charging station) having broken down, but the *Ray Mead*, which had a party on board, seemed not to have been affected by the same disaster. Supposing, however, that the charging dynamo had broken down, there are more charging stations and electric launches on the river, and we cannot think why such an unfortunate *contretemps* was allowed to arise.

Well, the electric *Viscountess* not being available, a steam *Duchess* was engaged, which, by the way, could have accommodated conveniently no more than the small contingent which arrived, and the journey was made. The luncheon provided for 44 proved amply sufficient for 22; the weather cleared as the day advanced; and Major Flood Page, who kindly took charge in the absence of Mr. Trotter, with much geniality and tact managed to convert a threatened *fiasco* into a fairly enjoyable excursion. When the Section again attempts an electric launch excursion we would suggest hiring the *Volta*, whose owners have never yet found it necessary to disappoint those who engage her.

### TELEGRAPH CLERKS AND THEIR GRIEVANCES.

THOUGH it may be urged, by those who regard them with perhaps unsympathetic feelings, that the present "agitations" amongst various sections of the working community are of "mushroom growth," still this cannot be said of the discontent and agitation existing in the Postal Telegraph service.

In Parliament, where the agitators have many friends, through the press, through the medium of public meetings, and by numerous petitions, the grievances peculiar to the telegraph clerks in the service of the Crown have

been again and again brought before the notice of the public, and since 1880-1 from time to time, at varying intervals, their claims to a better status have been made with a persistence, and, it must be added, a forbearance, which have not been without their effect on public opinion; and as a series of recent incidents appear to have somewhat accentuated their case, some reference to it here may prove of interest to our readers.

As is well known, a measure of reform was brought out in 1881 by the late Prof. Fawcett, who was at that time Postmaster-General. The great political economist had gone exhaustively into the varied features of telegraph clerks' grievances. Deputations of representatives—metropolitan and provincial—were closely and critically examined by him in the presence of a number of surveyors, postmasters, and other "permanent officials." A vast amount of evidence was placed before him, and, judging from what Mr. Fawcett afterwards said, was also accepted by him.

It is interesting to know that, though blind, Mr. Fawcett had such a faculty of recognising individuality of sound, that he was able on hearing a voice a second time to address the speaker by name, though the name had been but once mentioned.

It is also recorded that the permanent officials mentioned above did not receive these deputations with much show of favour or sympathy. To return, Mr. Fawcett declared that great hardships and grievances undoubtedly existed, and, in the result, the Fawcett scheme was the panacea which was to banish the ills of the whole service.

It would appear that it has failed to do so, and the lamented death of Prof. Fawcett may have curtailed the extent and scope contemplated for it by its author.

Sir John Puleston, M.P., it may be remembered, in addressing a crowded meeting of telegraph clerks at the Forester's Hall, London, last year, told them that when he congratulated Mr. Fawcett in 1881 on his efforts to do justice to telegraph clerks, the Postmaster-General replied, "Yes; but it is not enough." The effect of this remark on Sir John's audience may be imagined better than described; but it tends to show that the author of the Fawcett scheme did not look upon his labours as wholly accomplished, and his remark to Sir John Puleston may be said to be a very strong confirmatory point in the matter of the genuineness of the present grievances.

Now, as in 1881, the causes of dissatisfaction are attributed to:—

1. Inadequacy of pay.
2. Classification causing stagnation in, and irregularity of, promotion.
3. Deduction of pay during absence on sick-leave.
4. Undue length of duty.
5. Insufficient annual leave.
6. Inadequate pay for overtime.
7. Vexatious and unfair duties.
8. The performance by senior clerks of assistant superintendents' duties without extra remuneration or privileges.
9. Attendance on Bank Holidays without extra remuneration.
10. Lack of superior appointments.

Into each of these heads the telegraph clerks throughout the service have gone very fully in their petitions, and that they have made out a case may be inferred from the fact that the Postmaster-General, having received a report from a departmental committee, has made fresh recommendations to the Treasury, and their advent is awaited, we can fully believe, with feverish and pent-up anxiety. Unfortunately the Treasury enjoys, rightly or wrongly, the reputation of being a sort of monetary "Court of Chancery," whose deliberations are uncertain, occasionally arbitrary, and frequently protracted to an almost unbearable point.

Touching generally upon points into which we cannot enter in detail, some concessions have been made in the matter of sick pay, and if it is granted to a few there can be no good or just reason for withholding it from the remainder, irrespective of class.

We may say that the granting of Bank Holidays is not insisted on, and the telegraph clerks are not unreasonable in asking for overtime for such days.

Inadequacy of pay and classification, which latter gives rise to many anomalies in the matter of position, salary and service, are evidently the two standard grievances throughout the service. From what we have read, and from what we know of the service, it seems possible that the maxima which clerks might reasonably expect to reach will never be attained, and the question must surely present itself to the thinking mind whether it were not better to abolish the barriers at several stages, and allow a steady and gradual rise through the grades to a maximum, which, after all, even under the most favourable circumstances, would not be reached until after upwards of 25 years' service. It is no satisfaction to a man who has spent his years in faithful and meritorious service to be told, as has been done in our public departments, that "he is very unlucky," "he was just in an unfortunate position," or that he is "worthy of every encouragement," when none is forthcoming. The reward of faithful service lies chiefly in steady promotion, and before leaving the general question of pay, we may point out one very striking disparity which appears to be apparently unexplained. Take the case of senior clerks—previous to 1881, the difference between the maximum of a senior clerk in London and that of an assistant superintendent was £60. In 1881 the difference was increased to £80. In 1889 we find that the difference reaches no less a sum than £110. No sufficient reason is given for this remarkable expansion on the one hand, and the standstill on the other. Other cases could be shown, into other points want of space prevents us going. We know that the position of Mr. Raikes is one of difficulty and responsibility. He has expressed a becoming desire to be "just before he is generous." It may be that the events of the next week or so will prove that he can be both, and yet we do not know that the telegraph clerks are asking for more than simple justice. We venture to assert that the nation does not wish to see any of its public servants in positions in which they fail to receive adequate remuneration and consideration from the nation's purse.

Science, ever marching onward, leaves behind it new theories, new systems, and new labours. To electrical science this truism peculiarly applies, and it cannot be said that even now a telegraph clerk has nothing more to learn. The service, indeed, ever moves on with the sciences. We need not dwell on the specially-trained intellectual force that has to deal with current topics of all kinds, from the reports of great Parliamentary or scientific debates down to the humblest of telegraphic business. In all departments it may confidently be said that a high standard is maintained. It is but right to expect that those connected with the greatest telegraphic system in the world should be in positions more than one degree removed from the fringe of poverty; that they should feel that they are cared for by an appreciative administration, and it is to be hoped that the Postmaster-General will see that no unnecessary time is lost in readjusting the balance of justice.

In conclusion, we may say with Sir John Puleston that the claims put forward by these public servants are indeed moderate, and we hope that the tension at present existing may be carefully, manfully, and wisely controlled by the men, and that their conduct may be marked by extreme forbearance and a due consideration of the public service, as, we also trust, their claims will meet with a speedy, just, and liberal recognition at the hands of their professed friend the Postmaster-General.

**The Use of the Sprague Motor.**—On account of the efficient regulation of the Sprague electric motors many printing firms in the States have adopted it in preference to any other form of power. The Sprague Company has now about 20 motors in use in Boston for operating presses alone, while the total number in that city is about 200.

## NOTES.

**The Electric Light in Warfare.**—Some important electric light experiments were carried out in connection with the mobilisation of the Needles sub-section of the fortress of Portsmouth. The various forts and batteries which guard the western entrance to the Solent were supplied with powerful search lights, which have been fully engaged at night for the purpose of discovering the movements of the *Rattlesnake*, *Hecla* and other of Her Majesty's ships which were manœuvring in the vicinity.

**Proposed Electric Lighting at Exmouth.**—The Devon Electric Light and Power Supply Company, Limited, will apply for a provisional order for the lighting of the Exmouth Local Board district.

**Proposed Electric Lighting at Guildford.**—The House to House Electricity Company, Limited, has given notice of intention to apply to the Board of Trade for a provisional order, authorising them to supply electricity for public and private purposes in Guildford.

**Electric Lighting at Bromley.**—Messrs. Laing, Wharton & Down have given notice to the Bromley Local Board that they intend applying for a provisional order for the lighting of the town by electricity.

**Halifax and Bermudas Cable.**—The final splice was made on Monday last, and the cable will shortly be opened for the transmission of messages.

**Barnet Lighting.**—At the close of the meeting of the Barnet Local Board last week, Mr. James handed in the following notice of motion: "That the clerk be instructed to give notice to Mr. Joel and 'The Electric Light Company,' that this board will oppose any application by both, or either of them, for any provisional order or license extending beyond the term of Mr. Joel's contract with the board."

**The City Lighting.**—Says the *City Press*:—"When will the City be lit by electricity? The Commissioners of Sewers seem to be in no particular hurry, nor do the contractors for the two districts already apportioned. The third district will probably be kept in darkness to see how the other two get on. One contractor neglects to provide the necessary guarantee, and the other is supposed to be promoting a company to carry out the work."

**The International Exhibition of Mining and Metallurgy.**—The above exhibition will be opened next Thursday at the Crystal Palace. Among the probable English exhibitors may be mentioned Messrs. Davey, Paxman & Co., Richard Hornsby and Sons, Limited, Hathorn, Davey & Co., the Delta Metal Company, Limited, Sphincter Grip and Armoured Hose Company, Limited, W. H. Wilcox & Co., the Sandycroft Foundry and Engine Works Company, Limited, T. B. Jordan and Son, the Britannia Company, of Colchester, &c. Electrical firms will be conspicuous by their absence, Messrs. Woodhouse and Rawson United, Limited, being, as yet, the only intending exhibitors. Many South African and foreign silver, lead, gold, and copper mining companies will make a display of their products.

**Electric Stations and the Public Health.**—The Sanitary Council, Paris (Seine Department), has been requested to report upon the advisability of including electric stations in the list of *établissements insalubres*, by reason of the noise, trepidations, and smoke caused by them, and which have been bitterly complained of. In the last three years about 30 important electric stations have been erected in central positions.

**Execution of Kemmler.**—The latest report states definitely that Kemmler is to be executed by electricity.

**Small Capitals.**—The *Financial Times*, noticing the small capital (£100) of the Weston-super-Mare Electricity Supply Company and the Bristol Company, asks if the registrations emanate from the local gas companies for the purpose of protecting their interests. Our contemporary may be reassured on the point, and we recommend a closer scrutiny of the names of the promoters.

**Telephonic Communication Between Manchester and Dudley.**—The National Telephone Company notifies that communication has been established between Manchester and Dudley, and will henceforth be available.

**Cathcart and Peto.**—We learn that this firm has acquired the business and works of the Vulcan Manufacturing Company, makers of electric bells, indicators, &c., Roccliffe Street, Islington. The business will be carried on at the same address and under the same title as hitherto.

**The Elmore Wire Company.**—We hear that this company has contracts to take the whole of its output of copper spirals for the year 1891 at very remunerative prices. Mr. Elmore's latest invention in connection with the manufacture of mandrils for his process, we are assured is now a practical success. This is of great importance to the company, inasmuch as it has experienced the greatest difficulty in obtaining suitable mandrils.

**Electric Lighting at Thetford.**—The committee of the Mechanics' Institute has decided to fix the electric light throughout the building.

**F. H. Royce and Company.**—A revised price list of dynamos, dated 1st July, is being issued by Messrs. F. H. Royce & Co., of Manchester.

**Platinum.**—The difficulties attendant on the electro-deposition of platinum are well known, and the paper by Mr. Wahl, which we publish on another page, will prove a valuable addition to the literature, none too extensive, which exists on the topic. It is to be hoped that the day is not far distant when the application of platinum to plating purposes will become an industry of great importance, and *apropos* of this it may not be generally known that the price of this metal is about three times as much as was the case not long ago. One company, however, which uses this indispensable article in the manufacture of incandescent lamps was fortunate enough, when the market price was low, to lay in a stock sufficient to last for the next four years; a capital instance of the far sightedness of its well-known secretary.

**The Cost of Electric Traction.**—The General Electric Power and Traction Company will probably think it advantageous to give a reply to the assertions made by Mr. Willbond, during the discussion on electric tramways at the annual meeting of the Tramways Institute of Great Britain. To convert an assumed profit of £70 into an alleged loss of over £100 requires explanation, and we trust that the company is in a position to offer a satisfactory answer to Mr. Willbond's statements.

**Personal.**—Mr. A. P. Trotter has been appointed editor of the *Electrician*. We congratulate the proprietors of this journal upon such an acquisition to their literary staff.

**Birkenhead Electric Lighting Bill.**—This Bill, in an amended form, passed the Committee of the House of Commons on the 3rd ult.

**The Telephone in Italy.**—The Minister of Posts and Telegraphs contemplates the establishment of a system of telephonic communication all over the peninsula.

**Extension of the Telephone in Hampshire.**—Southampton and Bournemouth were connected last week by telephone.

**A Question of Wrongful Dismissal.**—In the Birmingham County Court, on Tuesday, Messrs. Snell and Prideaa, electrical engineers, Holloway Head, sued Thomas Lynch Hemming, electrical engineer, 94, Nursery Terrace, Hunter's Road, Handsworth, for £50 damages, for breach of contract to serve them for three years from 25th June, 1888. The defendant set up a counter claim for £249 as damages for wrongful dismissal in having refused to allow him to fulfill his agreement, and for the detention of certain tools and utensils. The case was tried by a jury. The jury gave a verdict for the plaintiffs for £30, and for the defendant for 7s. 6d. on the counter-claim.

**A New Insulator.**—The *Bulletin International de l'Electricité* mentions a new type of Berthoud-Borel cable, which is said to possess the property of insulation in a great degree. A layer of celluloid is first placed over the conductor, which is then encased in tarred hemp, over which a coating of some complex material follows. This last is said to offer a high insulation. Our contemporary is disposed to make light of the invention, seeing that celluloid possesses a high coefficient of dilatation, so that any sudden variations of temperature might occasion the loosening and destruction of the insulator, and, also, the inflammable nature of this material would have to be taken into account.

**Newspaper Enterprise.**—In consequence of the failure of the gas supply, the *Yorkshire Post* of Tuesday last week was produced entirely by the aid of wax candles. The text was written, the type set, and the paper was stereotyped and machined by the light of wax candles alone. Thursday's issue was to a large extent produced under very different conditions. The electric light was the illuminant in use from between 10 and 11 o'clock on Wednesday night. Such a rapid change from the modest wax-light to the brilliancy of electricity requires explanation. Because of the difficulty experienced on Tuesday night it was resolved on Wednesday morning by the management to introduce the electric light into the offices. The order for the installation was only given to Mr. Wilson Hartnell, electrical engineer, Leeds, at 11 o'clock on Wednesday morning, and it was at work at a few minutes to 11 at night. The power for driving the dynamo was, of course, already on the premises, it being derived from the engines working the printing machines. But the main shaft had to be cut for the driving pulley and a special countershaft provided, from whence the dynamo is driven, the latter running at 1,000 revolutions per minute. The installation consists of 40 lamps of 50 candle-power, and 20 lamps of 16 candle-power each, placed in the composing room, with six lamps of 100 candle-power in the machine rooms.

**Raw Hide Gear.**—In America the use of raw hide for gearing has come largely into use. It is often necessary to employ gear wheels running at a high rate of speed, and the wear which takes place, together with the accompanying noise, makes their use objectionable. Many attempts have been made to overcome these defects, and the patented solid raw-hide gears made by the New Process Raw Hide Company, of Syracuse, N.Y., have met with remarkable success. In the manufacture of the raw-hide, great pressure is applied, and all superfluous matter eliminated, leaving the same extremely light, and making it the strongest material for its weight known. The blanks are first cut, then a number laid together, and the teeth afterwards shaped out. The wheels so made have come into extensive use on electric cars, where their silent and even operation has added much to the comfort afforded by these cars. These gears may be run together or against metal gears, and require no lubrication. They are not only remarkably durable in themselves, but it is claimed that the life of large iron gears is longer, used in connection with them, than when running with metal pinions.

**The Western Gas Association of America.**—The Western Gas Association held its 13th annual meeting at St. Louis on May 21-23. In the course of his address, Vice-President C. R. Faben, Jr., of Toledo, O., said:—The electric light as a competitor to gas, for purposes of light, presents a solid front. How very profitable to investors these electrical undertakings may be, I question. From statements recently made I find that out of about 100 electric lighting companies in Massachusetts, only 15 declared dividends in the past year. Of these 15 companies 10 declared dividends of from 1 to 6 per cent., and only 5 declared dividends above 6 per cent. Leaving out the Boston companies, which by reason of the extent and value of their territory enjoy a greater demand for their light than exists in smaller places, the average of dividends paid by the electric light companies in the State, who paid dividends at all, has been only 4.9 per cent. Another fact in this connection is that no fund has been created by these several electric light companies to compensate for wear and tear. No depreciation has been charged off. The usual and necessary repair is supposed to represent all of the depreciations, so that the dividends paid are virtually taken from the plant itself or its value. Electric light companies are opposed to having any depreciation charged off other than the cost of repairs and renewals actually made.

**Wire Calculator.**—One of the most important problems to be solved by the practical wire man is that of proportioning the size of the wire necessary to carry safely and economically the amount of current requisite of charts and tables have been prepared with a view of helping wire men in this difficulty, but these at the for a given number of incandescent lamps. With the object of meeting the demand for something which would present the advantage of enabling the wire man to obtain results with great rapidity and conveniently, E. S. Greeley & Co., of New York, have have just put on the market a little device, called by the inventors an automatic wire calculator. It consists of two discs of stiff card-board of unequal size, the smaller one being mounted in the centre of the larger, and made to revolve thereon. On the back of the larger cardboard are full directions for the use of this unique and useful tool. One is arranged for the calculation of wire for of 110 volts, and it is understood another is in preparation arranged for 55 volts.

**The Alternating System in Russia.**—It is said the alternating system will be adopted by the Russian Government for lighting the buildings of the Imperial Palace, Zarskoe-Selo.

**Brighton Lighting.**—The committee has recommended that contracts to the extent of £7,027 be entered into with Messrs. Sharp and Kent, £5,242 with the Electrical Construction Corporation, £1,140 with Messrs. Sharp and Kent, in conjunction with Messrs. Goolden & Co., and £9,737 with Callender's Company. The net outlay, exclusive of the cost of the station site, will be, assuming only two sets of accumulators to be used, £26,887; with two extra sets, £29,429.

**The Electric Light in Lancashire and Yorkshire.**—Bills to confirm provisional orders made by the Board of Trade empowering the laying down of mains for the supply of electricity in Burnley, Morecambe, Bacup, Blackburn, Accrington, Blackpool, Huddersfield, Bury, Fleetwood, Lancaster, Salford, Crompton, Oldham, and Barnsley, have been before a committee of the House of Commons and passed, there being no opposition. A clause was inserted for the protection of telegraphic and telephonic wires.

**Electric Tramway in Bremen.**—The first electric tramway in Europe on the Thomson-Houston system was opened in Bremen on the 22nd ult. Three cars are employed, and others will subsequently be added. Each car carries two 10-H.P. motors.

**Journalists Exempt from Juries in New York.**—We note the following in the last issue of our transatlantic namesake:—"At last the journalistic profession has received recognition at the hands of the New York law makers. Editors and reporters will hereafter be excused from jury duty, ranking alongside of lawyers, physicians, and clergymen." When will the same privilege be granted in all cases here?

**The Praise-All Policy.**—In a recent number of the New York *Electrical Engineer* a description of a "Method of Telephonic Transmission," devised by a Mr. W. Vogel, is given; this description states that the invention "embodies a new application of the line wire to effect an increase in the efficiency of transmission. This is accomplished by maintaining the iron or steel conductor in a magnetic state, by which the effect of the vibrating armature of the transmitting telephone is propagated magnetically as well as electrically." The idea, which is about on a par with the spiral wire craze of a few years ago, is, we regret to see, spoken of in a leading article in terms which are not condemnatory of the absurdity of the so-called invention, though it is not urged that it might be a success; nevertheless, further trials of the apparatus in practical operation are suggested. We believe that under the able hands of the late editor, the whole matter would have been treated with the ridicule it deserves; moreover, a timely word might have saved the poor deluded so-called inventor a further useless expenditure of money which perhaps he can ill afford.

**News from Abroad.**—We are seriously thinking of the advisability of sending a few sub-editors to distant parts of the world, so that they may rapidly pick up information as to what is being done in London in electrical matters. We have, though fairly prompt, never succeeded in finding the items of news as rapidly as continental and American journals, and have come to the conclusion that being on the spot is the very worst way in which to acquire knowledge. Now, we were quite unaware that the Southwark Underground Railway had been opened, but an American contemporary announces that "recently there has been opened under the Thames a new subway, consisting of two tunnels each about 11 feet in diameter, for the use of an electrical railway, and trains consisting of a locomotive and three carriages, having accommodations (*sic*) for 100 passengers, are now run at frequent intervals from King William Street in the City to the Elephant and Castle in Surrey, a distance of a mile and a-third, in about three and one-half-minutes."

## NEW COMPANIES REGISTERED.

**Wakefield City and District Omnibus Company, Limited.**—Capital £6,000, in £1 shares. Objects: To carry on in Wakefield, or within a radius of 10 miles therefrom, the business of an omnibus and tramway company in all branches, and to work by means of horse, steam, electricity, or other mechanical power. Signatories (with 5 shares each): \*H. M. Carter, J. L. Chaplin, B. Woodcock, G. F. Roberts, \*F. K. Perkin, \*W. H. Kingswell, \*T. P. Robinson, W. Watson, Hy. Bennington, E. Long, H. Rollinson, \*H. Shaw, J. J. Hillbert, H. Smith, \*J. Cardwell, J. H. Holdsworth, J. Scott, G. Webster, W. Moorhouse, \*S. Stephenson, all of Wakefield and its vicinity. The subscribers denoted by an asterisk are first directors; qualification, £20 in shares or stock; maximum remuneration, £100 per annum. Registered office, Wood Street, Wakefield. Registered 3rd inst. by F. B. Moss, Outer Temple.

**Sherrin Electric Power Generator Company, Limited.**—Capital, £100,000 in £1 shares. Objects: To adopt an unregistered agreement between John Sherrin, John Vaughan Sherrin, and H. Ferdinand Woodgate, of one part, and G. M. Canham of the other part. To carry on business as electrical, mechanical, and chemical engi-

neers and manufacturers, and as an electric light company in all branches. To manufacture and deal in apparatus, materials, and things for the generation, distribution, supply, accumulation, and employment of electricity. Signatories (with 1 share each): G. M. Canham, Park Terrace, East Twickenham; W. J. Leslie Mumford, Applegarth Road, W; G. Jackson, 39, Aspland Grove, Hackney; S. H. Barnes, 84, Crofton Road, S.E.; R. B. Storey, 4, Vicarage Gardens, Forest Gate; D. R. Crane, 3, Erlam Road, South Bermondsey; E. Price, 2, Hanklin Road, Crouch End. The signatories and vendors are to appoint the first directors; qualification, 100 shares, and for subsequent directors 200 shares; remuneration, £2,000 per annum, divisible. Registered 4th inst. by Francis and Johnson, 5, Austin Friars.

*Note.*—The company referred to in our last issue as the Henley Electricity Supply Company, Limited, should read the Hanley Electricity Supply Company, Limited.

### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Fowler, Lancaster & Co., Limited.**—The statutory return of this company, made up to the 28th ult., was filed on the 5th inst. The nominal capital is £22,000 in £10 shares. 392 shares are taken up; upon 342 of these the full amount has been called, and £5 per share upon the remaining 50 shares. The calls paid amount to £2,600, and unpaid to £1,070. Registered office, Albert Works, Graham Street, Birmingham.

**Maquay Syndicate, Limited.**—The statutory return of this company is made up to the 23rd May. The nominal capital is £12,000, in 120 shares of £100 each, but the only shares at present taken up are the seven subscribed for by the signatories to the memorandum and articles of association. Registered office, 1, Shorter's Court, Moorgate Street, E.C.

**Liverpool Silver and Copper Company, Limited** (electrical treatment of metals).—The statutory return of this company, made up to the 10th April, was filed on the 22nd May. The nominal capital is £50,000, in £10 shares; 2,500 shares are taken up, and £3 per share has been called thereupon. The calls paid amount to £7,500. Registered office, 5, Fenwich Street, Liverpool.

**Poole and White, Limited** (electricians).—The statutory return of this company, made up to the 27th ult., was filed on the 3rd inst. The nominal capital is £20,000, divided into 3,400 "A" shares of £5, and 600 "B" shares of £5 each; 970 "A" and 600 "B" shares are taken up, the latter being considered fully paid. Upon the "A" shares £2 10s. per share has been called, the calls paid amounting to £2,425.

### CITY NOTES, REPORTS, MEETINGS, &c.

#### The India-Rubber and Gutta-Percha Company, Limited.

THE half-yearly general meeting of the company was held at Cannon Street Hotel on Thursday, the 10th inst., for the purpose of obtaining the shareholders' sanction to an interim dividend of 5 per cent., or 10s. per share (free of income tax), payable on and after the 11th inst.

The Chairman, Mr. S. W. Silver, in moving the resolution, said that a rough estimate of the amount of sales made in the past six months fully justified the payment, as the sales were in excess of those of any previous half-year, notwithstanding severe competition, and a considerable increase in the price of the raw material. The works were fairly well employed. These satisfactory results had only been attained by the closest attention and care.

Mr. Grey seconded the resolution and, referring to the recent strike at Silvertown, said that no loss had been occasioned by it, as the company had been able to execute its orders from its works in France. Had proper police measures been taken, the strike would have been prevented at the outset, instead of continuing for some twelve weeks. The loss to the workpeople had been about

£20,000, which they would have received had they continued at work. He hoped they would consider well the result of the last lesson before they struck again.

The motion was carried unanimously, and with a vote of thanks to the Board, the meeting dispersed.

#### The South of England Telephone Company.

THE report of the directors for the year ending 30th April, 1890, to be presented at the seventh ordinary general meeting to be held at Winchester House, on Friday, 18th July, at 12 o'clock, states:—The expenditure on capital account for the past year amounts to £14,116 2s. 10d., bringing the total of that account to £78,418 2s. 0d. The revenue account shows a sum of £21,549 18s. 9d. for subscriptions and rentals, and a net credit balance of £6,148 5s. 4d., making, with the sum of £627 1s. 2d. brought forward from last year, an available balance of £6,775 6s. 6d. Of this amount the sum of £1,796 14s. 7d. has been absorbed by the payment of an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ending 30th October, 1889. In order to strengthen the position of the company, the directors have considered it advisable to carry £1,000 to the reserve fund; and they now recommend the payment of a final dividend at the rate of 6 per cent. on the preference shares (£2,096 6s. 2d.), for the half-year ending 30th April, 1890, and the payment of a dividend of  $\frac{1}{2}$  per cent. on the ordinary shares, free of income tax (£1,500), for the year, leaving a balance of £382 5s. 9d. to be carried forward.

The completed trunk lines are as follows:—Brighton—Shoreham; Brighton—Eastbourne; Brighton—Worthing; Shoreham—Worthing; Brighton—Hurst; Brighton—Newhaven; Brighton—Rottingdean; Brighton—Lewes; Lewes—Eastbourne; Canterbury—Ramsgate; Ramsgate—Margate; Ramsgate—Sandwich; Ramsgate—Deal; Canterbury—Faversham; Canterbury—Whitstable; Canterbury—Dover; Dover—Folkestone; Chatham—Maidstone; Norwich—Great Yarmouth; Northampton—Wellingboro'; Wellingboro'—Kettering; Kettering—Rushden; Tunbridge Wells—Tonbridge.

The trunk lines in process of construction are:—Canterbury—Ashford; Faversham—Sittingbourne.

At the 30th April this year, 2,265 exchange lines and 583 private lines were completed, and 91 exchange lines and 19 private lines were in course of construction.

Telephone exchanges are now open at the following places:—Brighton, Cambridge, Canterbury, Chatham, Deal, Dover, Eastbourne, Faversham, Folkestone, Great Yarmouth, Hastings and St. Leonards, Hurst, Hythe, Ipswich, Kettering, King's Lynn, Lewes, Maidstone, Margate, Newhaven, Northampton, Norwich, Oxford, Peterborough, Ramsgate, Reading, Rottingdean, Rushden, Sandgate, Sandwich, Shoreham, Tunbridge Wells, Watford, Wellingborough, Whitstable, Worthing. Mr. D. Owen Bateson retires from the board by rotation, and, being eligible, offers himself for re-election. The shareholders' auditor, Mr. J. Weise, retires, and is eligible for re-election.

The following is a comparative statement of exchange and private line business of the company:—

		Exchange.		Private.
April 30th, 1886	...	687	...	248
April 30th, 1887	...	1,130	...	348
April 30th, 1888	...	1,521	...	386
April 30th, 1889	...	1,972	...	500
April 30th, 1890	...	2,356	...	602

**The India-Rubber Estates Company, Limited.**—The prospectus states that this company has been formed with a capital of £225,000, in 225,000 shares of £1 each, for the immediate purpose of acquiring and working a concession from the Government of the Republic of Liberia for the sole right of collecting and exporting India-rubber and gutta-percha from the republic, for the European and American markets, and with the intention of acquiring and working other valuable concessions relating to India-rubber and gutta-percha from other foreign Governments in Africa, America, Madagascar, and other parts of the world.

**The Eastern Telegraph Company, Limited.**—The directors after placing about £120,000 to reserve fund, recommend a balance dividend of 2s. 6d. per share and a bonus of 3s. per share, making a total distribution of 6 $\frac{1}{2}$  per cent. for the year ended March 31st last.

**The Allgemeine Electricitaats Gesellschaft of Berlin.**—This company will increase its capital by 3,000,000 marks. The new shares will be offered at 55 per cent. premium.

**The Telegraph Construction and Maintenance Company.**—An interim distribution of 12s. per share is announced.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 4th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,451.

The Great Northern Telegraph Company, Limited. The receipts for the month of June amounted to £24,600; 1st January—31st June 1890, £180,400; corresponding months 1889, £120,400; do. 1888, £132,000.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 3.)	Closing Quotation. (July 10.)	Business done during week ending July 10, 1890.	
					Highest.	Lowest.
£ 250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100 xd	97 — 100 xd	98½	98
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51		
2,725,420	Do. do. 6 p. c. Preferred	Stock	86 — 87	85½ — 86½	87	85
2,725,420	Do. do. Deferred	Stock	14½ — 15	14 — 14½	14½	14½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12 xd	11½ — 12½ xd	11½	11½
99,000	Do. do. 5 p. c. Bonds...	100	101 — 103	102 — 104		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107 xd	103 — 107 xd	103½	
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416...	3	2½ — 2½	1½ — 2½		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 1½		
\$7,216,000	Commercial Cable, Capital Stock	\$100	...	103 — 105	103½	
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	½ — ½	½ — ½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,000	Cuba Telegraph, Limited	10	12 — 12½	12½ — 12½	12½	12½
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited	5	3 — 4	3½ — 3½		
6,090	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	10½
400,900	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14½	13½ — 14½	14½	14
70,000	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 — 111	108 — 111	109½	
1,290,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	107½	
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14½ — 14½	14½ — 14½	14½	14½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	101 — 103	101 — 103		
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106 xd	103 — 106 xd	106	105
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106 xd	103 — 106 xd		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 — 103 xd	100 — 103 xd	100½	
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5½ — 6	5½ — 6	5½	5½
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	5	2 — 2½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited	10	9 — 9½	9 — 9½	9½	9½
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	15½ — 15½	15½	15½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½ xd	15½ — 16½ xd	15½	15½
40,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103 xd	100 — 103 xd	101	100½
250,000	Do. do. do. (issue of 1883)	100	104 — 107	105 — 108		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	12 — 13	12 — 13		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	19 — 20	19 — 20	19½	19½
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 — 105	103 — 105		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
109,000	Do. do. do. 6 p. c. Debentures	100	107 — 110	107 — 110	108½	108
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4½ — 5½	4½ — 5	5½	5
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5½ — 5½	5½ — 5½	5½	5½
49,825	Do. New Nos. 386,876 to 436,700	5	5½ — 5½	5½ — 5½	5½	5½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 13	12½ — 13	12½	12½
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10½ — 10½	10½ — 10½	10½	10½
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	4 — 4	4 — 4		
9,000	Reuter's, Limited	8	7½ — 8½	7½ — 8½		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	4 — ...	4 — ...	4	
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3½	2½ — 3½		
3,381	Submarine Cables Trust	Cert.	112 — 116	112 — 116		
78,949	Swan United Electric Light, Limited	5	5½ — 5½	5 — 5½	5½	
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	45½	44
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102 xd	100 — 102 xd		
55,000	United River Plate Telephone, Limited	5	4½ — 5	4½ — 5		
146,000	Do. do. do. 5 p. c. Debenture Stock...	Stock	90 — 94 xd	90 — 94 xd		
100,000	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	... — ... xd	... — ... xd		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9½ — 10½	9½ — 10½	10	
300,000	Do. do. do. 5 p. c. Debentures	100	99 — 102	99 — 102	101	99½
30,000	West Coast of America Telegraph, Limited	10	6 — 6½	6½ — 7	6½	6
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	108 — 112 xd	108 — 112 xd	110	109
64,572	Western and Brazilian Telegraph, Limited	15	10 — 10½	9½ — 10½	10½	10
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 7		
26,986	Do. do. do. 5 p. c. Deferred	7½	3½ — 4	3½ — 4	4½	4½
200,000	Do. do. do. 6 p. c. Debentures "A," 1910...	100	106 — 109	106 — 109		
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 — 107	104 — 107		
88,321	West India and Panama Telegraph, Limited	10	2½ — 2½	2½ — 2½	2½	
34,563	Do. do. do. 6 p. c. 1st Preference	10	11 — 11½	11 — 11½		
4,669	Do. do. do. 6 p. c. 2nd Preference	10	12½ — 13½	12½ — 13½		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
179,300	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 101	99 — 101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 2½	1½ — 2		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Electric Construction Corporation (£10 paid), 9½—10½.  
 —House-to-House Company (£5 paid), 5—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester  
 Edison and Swan Company, £9, (£1 paid), 11/-—12/-.

## WILLIAMS'S SELF-AMALGAMATING ZINC.\*

THE usual method of amalgamating battery zincs is by immersing them in a suitable acid mixture to clean their surfaces, and then spreading mercury over the surfaces which have been cleaned by the action of the acid mixture. The film of mercury on the zincs gradually disappears during the action of the cells and must be renewed by re-amalgamating or by keeping a quantity of mercury in contact with the zincs, usually in the bottom of the cells in which the zincs stand.

To avoid the trouble of frequent re-amalgamation, Dr. James B. Williams, of this city, has recently designed and patented a zinc which is self-amalgamating, and which is accomplished without removing the zincs from the cells.

The accompanying illustration gives a clear idea of the method employed by Dr. Williams as applied in the case of the plain cylindrical zinc. The cavity containing mercury, *M*, is formed entirely in the substance of the zinc. From near the bottom of the cavity a canal, *i*, runs obliquely in an upward direction, and its opening, *o*, is on a portion of the surface of the zinc which is



below the level of the battery solution. Another canal *h*, runs in an upward direction and terminates on a portion of the surface of the zinc which is outside the battery solution. The purpose of the canal, *i*, is to allow the battery solution to have access to the mercury in the bottom of the cavity, and that of the canal, *h*, to allow mercury to be poured into the cavity without removing the zinc from its cell. The cavity and its outlets are formed in the zinc during the process of casting or by drilling.

To prepare the zincs for use, they are first amalgamated in the usual manner, a quantity of mercury placed in the cavities, and the zincs placed in their cells. If the zinc bodies are used, they are first fastened to their zincs and amalgamated with them in the usual manner, and a quantity of mercury placed in their cavities, after which they are placed in their cells. The mercury is renewed from time to time, as the film of mercury on the zincs is removed during the action of the battery. The zincs continue to be self-amalgamating until the zinc is dissolved to such an extent that the cavity will no longer retain the mercury which is poured through the canal, *h*.

\* Electrical Engineer, New York.

## NOTE ON A NEW PHOTOMETER.\*

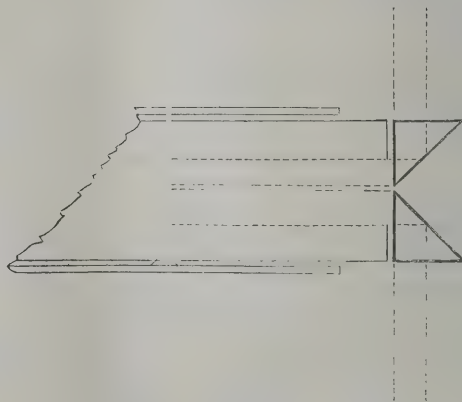
By EDWARD L. NICHOLS.

METHODS of photometry, which take no cognizance of differences of quality, are so ill adapted to the study of sources of light which differ from each other widely in temperature, that the introduction of some instrument by means of which both the character and intensity of an illuminant can be readily determined, would be a desirable adjunct to the equipment of our photometer rooms.

The instrument which it is my purpose to describe, has been designed to meet this need. Existing types of the spectrophotometer may be made to give good results, but they are expensive instruments, and so difficult to use that it is only in the hands of observers of considerable experience that accuracy is assured.

The new apparatus, the "horizontal slit" photometer, is, in point of fact, a spectrophotometer, in which the polarising device is entirely done away with. In it the extremely simple principle of the Bunsen photometer is applied successively to the various regions of the visible spectra of the source of light which are to be compared. A direct vision spectroscop of Brown-ing's form is attached to the usual car of a Bunsen photometer, from which the disc and mirrors have been removed. The optical axis of the collimator is horizontal and at right angles to the photometer bar. The slit is horizontal and lies in a straight line joining the sources of light, which are set up in the usual manner at the ends of the bar. The bar itself is preferably of considerable length—in the case of the one upon which the original instrument under consideration was mounted it was 500 c.m. long—and should be divided into 1,000 equal parts.

In front of the spectroscop slit are placed two right angled prisms of the same size, and made of the same glass (see cut). Their vertical adjacent edges bisect the slit, and light travelling from either end of the photometer bar is totally reflected by them, and enters the right and left hand end of the slit in a direction parallel to the optical axis of the collimator tube.



The two sets of rays thus gathered into the spectroscop from the lights at the end of the bar are vertically dispersed by the Amici prisms, and appear in the field of view as two vertical spectra standing side by side. Equal wave lengths are in the same horizontal line, and any desired region may be brought into the centre of the field by an angular movement of the ocular telescope. The telescope moves along the arc of a suitably divided semicircle, to which it may be clamped by means of a set screw. Wave lengths, corresponding to the various circle settings, are determined once for all by observation of the more prominent of the Fraunhofer lines.

When the instrument thus mounted is placed at the middle of the photometer bar between lamps which are identical in intensity and quality, the two spectra are of

\* Read at the Annual Meeting of the American Institute of Electrical Engineers, Boston, May 20th.

equal brightness throughout, wave length for wave length, from red to violet. If the two lamps differ in intensity but not in quality, the two spectra will differ in brightness by the same amount from end to end, and a position may be found upon the bar for which they will be identical throughout.

Under these circumstances, which are the only ones in which the Bunsen method in photometry is strictly applicable, the instrument may be used as a simple photometer, the setting for any wave length whatever giving the candle-power. For this purpose alone, viz., for the comparison of lights of similar character, the instrument offers certain manifest advantages over the various forms of the Bunsen photometer. In the course of the present paper I shall present some definite data concerning the relative sensitiveness of the two instruments when used in this way.

When the lights to be compared differ both in intensity and quality, ordinary photometric indications possess no perfectly definite significance. In this, which is the more general case, the relative brightness of the spectra of the two sources varies with the wave length. For each region of the visible spectrum, however, a position upon the photometer bar can be found at which the brightness of the two spectra in that region will be equal, and the observations thus obtained, when extended over the entire spectrum, will afford data by means of which the differences in quality of the two sources of light may be definitely expressed.

In a recent paper read before the institute (*Transactions of the American Institute of Electrical Engineers*, Vol. VI., p. 183), for a considerable range of temperature at least, the ratio between the intensities of a certain wave length of the spectrum of glowing carbon, is identical with the ratio of candle-powers, as determined by the Bunsen photometer. The wave length in question, determined from the intensity of the spectrum of incandescent lamps at various candle-powers, I had found to be approximately  $\lambda = 600$ . M. A. Crova, in an important paper since presented at the late electrical congress at Paris,\* has pointed out the importance of this method of measuring the light from sources differing in temperature. The wave length which he has indicated for this purpose is  $\lambda = 582$ , which belongs to a region lying slightly farther toward the green than the one which I had adopted.

When the wave length of this region has been established beyond question, the photometry of lights which vary in colour, will have been reduced to a definite scientific basis. Instead of attempting to use the Bunsen photometer in measurements to which it is not adapted, we shall be able to deduce the relative candle-power of two sources of light from the comparison of a single wave length, and we shall be freed from the uncertainty arising from differences of colour and from the personal errors due to the independent use of the two eyes in observation. The determination of candle-power will then be an operation of precision, even when the sources of light to be compared vary widely in temperature. It is in the opportunity of performing such observations upon the photometer bar itself, under conditions which do away with many of the sources of error inherent in the usual methods of spectrophotometry, that the chief advantage of the new photometer will be found to lie.

The following set of observations, taken with the new instrument, may serve to indicate one of the uses to which it may be put. The data are taken from an investigation now in progress in the physical laboratory of Cornell University. The object in view was to compare the spectrum of a novel type of gas burner with that of an ordinary argand burner. The two lamps were set up at the ends of a photometer bar five meters long, the bar, as already stated, being divided into 1,000 equal parts. Readings were taken at six points in the spectrum. The purposes being to express the relative brightness of the two spectra, wave length for

wave length; the intensity of that due to the argand burner was taken as unity throughout, and the brightness of each region of the spectrum of the flame under investigation was obtained in terms of that of the corresponding region of the spectrum of the argand. The results are given in Table I.

TABLE I.

Comparison of the spectrum of a Welsbach burner with that of an ordinary argand burner by means of the "horizontal-slit photometer."

Colour.	Wave length.	Light ratio, Welsbach Argand.	Probable error of a single observation.
Red ... ..	702	0.709 $\pm$ .017	2.45 per cent.
Yellow ... ..	589	1.476 $\pm$ .017	1.14 "
	558	1.760 $\pm$ .023	1.34 "
Green ... ..	500	2.395 $\pm$ .047	1.99 "
Blue ... ..	466	2.738 $\pm$ .036	1.30 "
Violet ... ..	439	3.090 $\pm$ .073	2.35 "
			1.76 { (Average)

From observations by Miss Ida M. Hill.

Ten observations were made in each region.

I introduce these measurements here simply as an illustration of one line of work to which the instrument under consideration is adapted. A full description of the research of which they form a part, and which covers many other questions pertaining to the very interesting class of lamps with which it deals, will doubtless be published in due time.

As will be seen from the column of probable errors the sensitiveness of the instrument is greatest in the region of the D line ( $\lambda = 589$ ), and least in the extreme red and violet, where the light intensities are small.

A set of ten determinations made by the same observer with the Bunsen photometer gave for the total light ratio of the two lamps :

$$\frac{\text{Welsbach}}{\text{Argand}} = 1.701 \pm .015$$

The probable error of a single observation in this series amounted to 0.89 per cent., a value somewhat smaller than that obtained with the new photometer in the yellow of the spectrum.

The number of observations is too small to afford a close estimate of the relative sensitiveness of the two instruments, but the results suffice to show that the "horizontal slit" photometer does not differ appreciably in accuracy from the Bunsen photometer when the latter is used in the comparison of flames of the same colour.

When it comes to the measurement of sources of light that differ widely in temperature the comparison is decidedly in favour of the "horizontal slit" photometer, the sensitiveness of which is not affected by differences of colour. The error of the Bunsen photometer in candle-power measurement of the arc light, for instance, calculated from ten observations recently made upon the same photometer bar, the reference standard being an argand gas burner, was 2.65 per cent. (probable error of a single observation), a value more than twice as large as that of the "horizontal slit" photometer.

A comparison of the performance of the new photometer with that of a polarizing spectrophotometer of the type which is commonly recognised as affording the highest degree of accuracy, is decidedly in favour of the former. Taking as a basis eight observations made by Mr. Franklin and myself in the study of a bat's-wing gas burner,\* the observations covering eight regions of the spectrum, I find the error of a single

\* M. A. Crova, *La Lumière Electrique*, Vol. XXXIII., p. 478.

\* *American Journal of Science*, Vol. 38, p. 100. See also *Transactions of the American Institute of Electrical Engineers*, Vol. 6, p. 177.

observation in the various regions to have been as follows :

TABLE II.

Probable errors of a single observation with a polarising spectrophotometer, calculated from sets of 10 observations upon various portions of the spectrum of a gas flame.

Wave lengths.		Probable error of a single observation.
753	...	7.9 per cent.
668	...	4.9 " "
608	...	4.5 " "
557	...	5.4 " "
518	...	6.4 " "
492	...	7.0 " "
468	...	3.0 " "
450	...	2.4 " "
		5.2 per cent. (average).

The measurement of a fluctuating illuminant, such as the gas flame, is a line of investigation by no means adapted to exhibit any photometric instrument at its best ; but as the errors of the horizontal-slit photometer, already given, were calculated from sets of 10 observations upon such flames, I have selected for comparison similar sets of 10 upon sources of the same character.

The averages, viz. :—

Error of horizontal-slit photometer 1.76 per cent. (average for spectrum). Error of polarising spectrophotometer 5.20 per cent. (average for spectrum) doubtless afford a fair indication of the relative performance of the two instruments in this peculiarly trying line of work.

At the last annual meeting of the Institute I had the privilege of presenting a brief study of certain personal errors pertaining to the use of the Bunsen photometer. The particular class of errors to which attention was called in that paper are undoubtedly obviated by the use of the horizontal-slit photometer ; what new ones the latter instrument may introduce remains to be determined.

## ON THE ELECTRO-DEPOSITION OF PLATINUM.\*

By WM. H. WAHL.

THE permanence and unalterability of the metal platinum—properties which make it of such inestimable value to the chemist—have likewise suggested its application as a protective covering upon the surfaces of other metals ; and, even in the early days of the art of electro-deposition, efforts to obtain a satisfactory coating of this metal were made. The failure with which these early experiments were attended served rather to stimulate than to deter subsequent investigators, and the problem has received the attention of a number of the most noted experts in the art. The results that have been accomplished cannot be said to have been entirely satisfactory—a statement which, I believe, will be fully sustained by the fact that electro-plating with platinum, on the commercial scale, is practised only to a very limited extent. When the wide field of application for platinum-plating is considered—and I need only name philosophical, engineering, surgical, dental and electrical apparatus and instruments, fire-arms, watch-cases, and jewellery, to say nothing of the host of miscellaneous articles of utility and ornament to which the metal could be advantageously applied—the conclusion is irresistible, that the processes thus far proposed for the purpose do not fully meet the requirements of practical service.

Thus far, of all the methods that have been proposed for electro-plating with platinum, three only appear

to have sufficient merit to deserve special notice ; these are :—

1. Roseleur-Lanaux method, based on the electrolysis of a solution of the double phosphate of sodium and platinum.

2. The process of the Bright Platinum Plating Company, of London, a modification of that of Roseleur, involving the introduction into the bath of certain substances, such as sodium chloride and borax, to ensure a bright deposit of the metal ; and

3. Boettger's method, founded on the electrolysis of a solution of the double chloride of ammonium and platinum in sodium citrate.

Each of these baths will yield satisfactory results for a time ; but, as I shall endeavour to show, the peculiar difficulties met with in the practice of platinum-plating render it impossible to maintain the chemical integrity of these electrolytes, and, in consequence thereof, they soon become inefficient or inoperative by reason of contamination with the secondary products formed therein.

I will endeavour in what follows to give the true explanation of the difficulties above referred to, and to indicate what, from a careful study of the subject, fortified by the results of numerous experiments, I conceive to be the only feasible method of overcoming them.

The first difficulty encountered is that of obtaining a bright, reguline and adherent deposit of the metal, in which form only it will answer the demands of practice. There is no difficulty in effecting the separation of the metal from solutions of almost any of its compounds. Zinc, iron and tin reduce it promptly by simple immersion, and this very facility of reduction is one of the reasons why, even by the method of electrolysis, the desired object is frequently accomplished only in an imperfect manner ; for the electro-plater is obliged to meet and overcome its obstinate disposition to separate from many of its compounds in the condition of platinum black, lacking coherence and adherence, and therefore entirely unsuited for his purpose.

Another and no less serious difficulty arises from the insolubility of plates or sheets of this metal as anodes, when solutions containing platinum salts are submitted to electrolysis. In electro-plating with copper, silver, gold and nickel, but little difficulty is encountered in practice on this account, since anodes of these metals are freely soluble in many solutions capable of depositing them when they are submitted to electrolysis, and the rate at which these anodes are respectively dissolved, approximates so nearly to that at which the metals are deposited upon the objects at the cathode, that the metallic strength of the electrolyte is maintained substantially uniform, and electro-plating solutions of these metals may be operated for a long time without requiring additions of metallic salts. The electro-deposition of the metals whose anodes are thus tractable is carried on industrially with success.

It results from this want of solubility of the anode that the metallic strength of the electrolyte employed is continuously being weakened, while the deposition of the metal is going on, and the conductivity of the bath is being continually modified thereby. The character of the deposited metal also is injuriously influenced by these constant alterations of condition in the bath ; and, as the rate of deposition becomes slower and slower by reason of the gradual impoverishment of the metallic strength of the solution, it will be necessary to restore it by fresh additions of metallic salt. The practice in all the processes of electro-plating with platinum employed up to the present time, save that of Boettger, is to use for this purpose the tetra-chloride of platinum. With this single exception, all the solutions for the electro-deposition of platinum thus far made known, so far as I am aware, are made by treating the chloride with compounds of the alkalies, soda, potassa, or ammonia. Of these, the phosphates and oxalates of soda, or potassa, are in greatest favour, and a number of formulæ for preparing platinum-plating baths with their aid have been described. The resulting sub-

\* Read at the Stated Meeting of the Chemical Section, Franklin Institute, May 20th, 1890.

stance is commonly a double salt, such, for example, as the double phosphate of sodium and platinum; the double oxalate of potassium and platinum, &c., contaminated, however, in each case by the chloride of the alkali employed, which is formed from the decomposition of the platinic chloride. As often as it is found necessary to strengthen the bath, fresh additions are made of platinic chloride, which, by chemical interaction with the constituents of the bath, aided by the process of electrolysis, yields more alkaline chloride; and it follows that the bath, by reason of becoming surcharged with this foreign substance, and with other secondary products of electrolytic decomposition, ceases to yield bright, reguline platinum upon the articles to be plated therewith, and must be discarded. It then becomes necessary to regain the platinum contained in the discarded bath, by one or another of several processes of reduction known to chemists. The platinum thus regained may be converted into chloride and utilised in the preparation of a fresh bath, with which the same series of operations will be repeated. Boettger purposes to maintain his bath by fresh additions of his original solutions, but it must be apparent that the continued electrolysis of such a solution as he employs must be attended with the constant accumulation therein of alkaline chlorides from the same causes as those specified above. This rapid deterioration of the baths, therefore, involve their frequent renewal at the expense of time and labour, so that, in spite of the fact that there is a wide field for its application, it is principally for this reason that the art of electro-plating with platinum on the commercial scale has thus far been practised only to a very limited extent.

It occurred to me that it might be practicable to overcome the principal difficulty here set forth. Knowing the influence of extent of surface in promoting the solubility of substances, it appeared to me at least probable that if the platinum were exhibited at the anode in the form of platinum black, or sponge, exposing thus an enormously greater number of points of attack to the electro-negative element or acid radical there set free, the result might be the solution of the platinum, and the problem of maintaining the metallic strength of the electrolyte would thus be solved. The correctness of this conjecture was verified by experiment. For this purpose a plate of porous battery carbon, previously treated with boiling hydrochloric and nitric acids, was saturated repeatedly with a solution of platinic chloride and dried. It was then introduced into a graphite crucible, finely divided carbon was packed about it, and the crucible and contents heated for about half an hour to bright redness. The carbon plate then contained within its pores platinum in a state of eminently fine division. Treatment with water, and with hydrochloric acid at boiling temperature, failed to leach out any platinum salt, showing that the previous treatment had sufficed to reduce all the platinum salt to the metallic state. The carbon plate was then suspended as the anode in moderately diluted hydrochloric acid, a platinum plate serving as the cathode. The acid bath was gently heated and a current of moderate strength was allowed to flow through it. There was a liberal evolution of hydrogen from the cathode, but little perceptible evolution from the anode. The acid solution gradually became coloured from the formation of platinic chloride, and after some time the bright surface of the cathode began to blacken and ultimately became covered with a thick coating of platinum black. It was thus demonstrated that an anode of platinum in a fine state of division is readily soluble in an electrolyte which yields chlorine at the anode when the same is electrolysed. This observation, so far as I am aware, is new. It proved, however, to have no practical value, since the solution of the anode demanded the presence of a large proportion of free acid in the plating-bath, and the use of currents of such strength as to produce invariably the deposition on the surfaces to be plated of black and non-adherent metal. Furthermore, it was found, as was to have been anticipated, that the physical condition of the anode exerted no influence whatever in the electro-

lysis of baths formed of the oxy-salts of platinum, from which the best results in electro-plating are obtained—since, in electrolysing such compounds, the acid radical separated upon the surface of the platinum black failed to exert any perceptible solvent action.

It was therefore necessary to devise some other plan for overcoming the difficulties herein described, and, after making a number of fruitless experiments, I was so fortunate as to find a plan which appears to offer a solution of the troublesome problem of electro-plating with the group of metals, whose anodes are insoluble, in a more satisfactory manner than any other that has hitherto been suggested.

The plan here referred to consists in employing platinum hydroxide for the purpose of maintaining the metallic strength of the plating bath. For this purpose, the hydroxide, which is readily soluble in alkalies and in many of the acids, may be introduced into the plating bath from time to time and dissolved therein by stirring, or it may be permitted to remain in the bath in excess, the undissolved portion remaining at the bottom of the containing vessel, or it may be suspended in a canvas bag adjacent to or surrounding the anode of carbon, according as the nature of the electrolyte may indicate one or the other method to be the preferable one. As the solutions which yield the best results in plating are those of the oxygen salts, I have found it advantageous also to prepare these directly from the hydroxide. This method, I have found, is capable of yielding a number of electrolytic baths of platinum that will maintain their metallic strength approximately unimpaired during electrolysis, and without the objectionable features of introducing into them substances that will cause them to deteriorate by the accumulation therein of injurious secondary products of decomposition, as is the case where such baths are maintained by additions of platinic chloride or alkaline chloro-platinates, as has hitherto been the invariable practice. Referring now specifically to the properties that render the platinic hydrate useful for the purposes above indicated, the following points appear to be deserving of mention.

It is readily soluble in aqueous solutions of the alkaline hydrates, and in a number of acids, mineral and vegetable. In the treatment of the platinic hydrate with aqueous solutions of the alkaline hydrates, the former plays the part of a weak acid forming compounds known as platinates, which are very soluble, and from which the platinum is not precipitated on the addition of an excess of alkali. A weak aqueous solution of sodic or potassic hydrate (but especially the last-named) will dissolve a large quantity of platinic hydrate, at the ordinary temperature, though solution takes place more freely when heat is applied. These solutions have the advantageous features of being freely conductive of electricity, and of yielding bright, reguline and adherent electro-deposits of platinum on metallic surfaces previously prepared to accept the same. Furthermore, with a current of moderate strength, the platinic hydrate only is affected, as is shown by the pronounced evolution of oxygen at the anode, and by the total absence of gas at the cathode. Also, it is manifest from the free solubility of platinic hydrate in alkaline hydrate, even in the cold, that if free platinic hydrate be present in a bath of alkaline platinate, the alkali set free in the process of electrolysis will combine with this platinic hydrate to form fresh platinate. For this purpose it will be necessary either to have present in the bath at all times a small excess of platinic hydrate which may remain upon the bottom of the containing vessel, without interference with the plating, and which may be replenished from time to time; or to introduce, at the end of the day's work, a quantity of the platinic hydrate sufficient to restore the metallic strength of the bath to normal, assisting the solution of the metallic hydrate by stirring, and, if necessary, by the application of gentle heat. As I have found that the platinate solutions act best when they contain a considerable excess of free alkaline hydrate, being more conductive of the current and yielding the platinum more freely and in the best condition, the addition of the proper quantity

of platinic hydrate at the close of the day's work in the case of a bath of considerable volume, or the addition of small quantities at intervals, in the case of a small bath, will be found to answer the desired purpose of maintaining the metallic strength of the bath approximately normal for an indefinite period. In a bath where considerable free alkali is present the platinic hydrate added, as just indicated, dissolves very freely even in the cold. The important fact is to be noticed that the alkaline platinate solutions may be maintained and operated for a long time in the manner described, since no deleterious secondary products are formed by electrolysis to vitiate and render them inoperative, as will speedily be the case where the platinic chloride is used for this purpose. The mineral acids (hydrochloric, nitric, sulphuric, and phosphoric acids) dissolved the hydroxide freely, as likewise do certain of the vegetable acids, notably oxalic acid, and form with corresponding salts of the alkalies, double salts, many of which are soluble in water. Of the salts thus capable of being formed, however, so far as I have been able to determine by experiment, only a limited number appear to be adapted to yield a deposit of bright, reguline and adherent platinum. The halogen compounds may obviously be prepared more conveniently by the direct solution of the metal in *aqua-regia* than by the method I have described, but as I have found the oxygen compounds of platinum to yield much more satisfactory results, I therefore exclude them from consideration.

Of the salts that may be formed from platinic hydrate by solution in acids (and in part by suitable combination with the corresponding alkaline compounds to form double salts), three only may be named as sufficiently useful to yield practically valuable results in plating. These are the phosphates, oxalates and acetates, of which also it is practicable to form double salts with the alkalies, soda, potassa and ammonia, which yield bright, reguline and adherent plating.

Oxalic acid, so far as I have been able to determine, of all the oxygen acids, is the best solvent of platinic hydrate, dissolving it even in the cold, but with great energy when aided by heat, and forming platinous oxalate, with evolution of carbonic anhydride. From this brownish-black or deep blue solution (according to concentration), brilliant reddish-brown scales of the salt separate abundantly and readily from the hot saturated solution. A saturated aqueous solution of the simple oxalate prepared from the hydrate, as above described, will yield bright, reguline, adherent platinum when electrolysed with a comparatively weak current, with evolution of carbonic anhydride at the anode. With a stronger current hydrogen also appears at the cathode. This bath may be maintained indefinitely at normal metallic strength by observing the precaution to add oxalic acid and platinic hydrate in small quantities from time to time; or by keeping constantly at the bottom of the bath some platinic hydrate, and adding oxalic acid in crystals or powder from time to time as may be required to keep the bath saturated; or, what is much to be preferred, making a supply of platinous oxalate from platinic hydrate in the manner previously described, and keeping an excess of this present in the bath at all times. This bath has the same advantages as are possessed by the above-described alkaline platinate baths, of being capable of indefinite maintenance at normal metallic strength, and of introducing no substances that will cause its deterioration by the formation of secondary decomposition products.

Phosphoric acid also is a solvent of platinic hydrate. A dilute aqueous solution of this acid will dissolve a small quantity of the metallic hydrate in the cold, and a much larger quantity when aided by heat. With increasing concentration, the solvent power of this acid for platinic hydrate is correspondingly increased. The resulting solution of phosphate of platinum, according to the degree of concentration, will be wine-yellow to cherry-red in colour, and with a comparatively weak current, will yield bright, reguline and adherent platinum on metallic surfaces properly prepared to accept

the same. The electrolysis of this compound, also, does not involve the formation of deleterious secondary products, the result of the operation being the separation of the metal at the cathode, and of the acid radical at the anode—and of the elements of water which are evolved as gases respectively from anode and cathode. In the operation of the bath, therefore, it will become more and more acid as the metal is withdrawn by the accumulation therein of the phosphoric acid set free at the anode. The maintenance of the metallic strength of the bath, therefore, may be effected as in the foregoing cases, by having present therein at all times a small quantity of platinic hydrate, or by the addition at the end of each day's work of the quantity of the metallic hydrate which will be required to restore the amount of metal withdrawn. This bath must be worked very acid, and the solution of the platinic hydrate to maintain the strength of the bath must be facilitated by heating, as the solvent power of phosphoric acid for platinic hydrate is much inferior to that of oxalic acid. The double phosphates of platinum with certain of the alkalies may be formed, which will be capable of yielding a deposit of bright, reguline and adherent metal, and of being maintained approximately at normal metallic strength in the same manner as I have set forth above. The best results I have obtained with the ammonio-platinic phosphate, prepared by adding to the solution of platinic hydrate in phosphoric acid sufficient aqua ammonia to cause the same to give an alkaline reaction, which point will be indicated by the formation of a grayish precipitate that will not disappear on stirring; then restoring the acidity of the solution by adding free phosphoric acid in excess, upon which the precipitate readily dissolves. The resulting solution is yellowish or brownish, and yields superb plating; though, on account of the greater difficulty of maintaining its metallic strength by the solution of the hydroxide, it is not so well adapted as the oxalate for the work of electro-deposition on the large scale. The sodio-platinic phosphate, formed in a manner precisely analogous to the ammonia compound just described, will also yield bright, reguline and adherent plating; but I have observed that the soda salt is less freely soluble than the corresponding ammonia compound, and consequently more difficult than the latter to maintain of normal metallic strength.

Platinic hydrate is only very sparingly soluble in strong acetic acid, and it is impracticable to facilitate the solution by boiling, since by persisting in this for a very short time, the hydrate is decomposed, and black platinic oxide is formed, which is quite insoluble in this menstruum. I have found, however, that an alkaline acetate bath may be prepared by the addition to the alkaline platينات above described, of as much acetic acid as may be introduced without causing the formation of a permanent precipitate. But although the appearance and quality of the plating obtained with this bath leave nothing to be desired, the bath does not meet the requirements in respect of indefinite maintenance in normal metallic strength and uniform composition. This difficulty, however, as I have observed, becomes less and less pronounced as the bath is made more strongly alkaline, when it approximates more and more closely to the alkaline platينات; for it is obvious that in the presence of a large amount of free alkali, this would unite with the acetic acid to form a simple acetate. The resulting solution would no longer contain sodio- (potassio-) platinic acetate, but sodic (potassic) acetate, sodic (potassic) platinate, and free alkali. Nevertheless, the presence of acetic acid in such alkaline bath appears favourably to influence the quality of the plating yielded, giving the deposited metal a whiteness approaching that of silver; and since, furthermore, acetic acid yields only the elements of water and volatile compounds when electrolysed, and therefore does not contaminate the electrolytic bath by forming deleterious secondary products, I find its judicious addition to the above-described alkaline platinate baths to present some advantages.

The foregoing comprise the compounds that I have found to yield the most satisfactory results in platinum

plating, and I will not tax your patience at this time by an enumeration of the results, either partially successful or wholly unsuccessful, that I have obtained with a number of differently constituted compounds of this metal.

I append directions for the preparation of the several electrolytic baths above described, and indicate what I have found to be the most favourable conditions for working them.

In conclusion, I desire to make known the fact, which was brought to my knowledge only within the past week, that my friend, Prof. Wm. L. Dudley, of Vanderbilt University, Nashville, Tenn., has independently worked out the problem of electro-plating with iridium in a manner precisely analogous to that which I have herein described with platinum. Prof. Dudley has made no publication of his research, but in a letter informs me that he employed, as long ago as 1886, the following procedure, which I quote, "a bath of the metal may be composed of either the chloride ( $\text{Ir Cl}_4$ ), the double chloride of iridium and sodium, a double sulphate of iridium-ammonium. The latter was preferred. The bath was kept saturated with metal by suspending canvas bags in the solution (either near to or around the anodes) containing the hydroxide of iridium."

*Directions for Preparing the Electro-Plating Baths.*—For the alkaline platinate bath, the following directions may suffice :—

Platinic hydrate	...	...	...	2 oz.
Caustic potassa (or soda)	...	...	...	8 oz.
Distilled water	...	...	...	1 gallon.

Dissolve one-half of the caustic potassa in a quart of distilled water; add to this the platinic hydrate in small quantity at a time, facilitating solution by stirring with a glass rod. When solution is effected, stir in the other half of alkali dissolved in a quart of water; then dilute with enough distilled water to form one gallon of solution. To hasten solution, the caustic alkali may be gently heated, but this is not necessary, as the platinic hydrate dissolves very freely. This solution should be worked with a current of about two volts, and will yield metal of an almost silvery whiteness upon polished surfaces of copper and brass, and quite freely. There should be slight, if any, perceptible evolution of hydrogen at the cathode, but a liberal evolution of oxygen at the anode. I have observed that the addition of a small proportion of acetic acid to this bath improves its operation where a heavy deposit is desired. The anode may be of platinum or carbon, and owing to the readiness with which the metal is deposited an excess of anode surface is to be avoided. Articles of steel, nickel, tin, zinc, or German silver, will be coated with black and more or less non-adherent platinum; but by giving objects of these metals a preliminary thin electro-deposit of copper in the hot cyanide bath, they may be electro-platinised in the alkaline platinate bath equally as well as copper. The bath may be worked hot or cold, but it is recommended to work it at a temperature not exceeding 100° F. It may be diluted to one-half the strength indicated in the formula, and still yield excellent results. The surface of the objects should be highly polished by buffing, or otherwise, prior to their introduction in the bath, if the resulting deposit is designed to be brilliant.

The deposition of platinum takes place promptly. In five minutes a sufficiently heavy coating will be obtained for most purposes. The deposited metal is so soft, however, that it requires to be buffed very lightly. A heavier deposit will appear gray in colour, but will accept the characteristic lustre of platinum beneath the burnisher.

The oxalate solution is prepared by dissolving one ounce of platinic hydrate in four ounces of oxalic acid, and diluting the solution to the volume of one gallon with distilled water. The solution should be kept acidified by the occasional addition of some oxalic acid. The simplest plan of using this bath, and which requires no attention to proportions, is simply to work with a saturated solution of the oxalate, keeping an

undissolved excess always present at the bottom of the vessel. An addition of a small quantity of oxalic acid now and again will be found advantageous. The double salts of oxalic acid with platinum and the alkalies may be formed by saturating the oxalate of the desired alkali, with platinic hydrate and maintaining the bath in normal metallic strength by the presence of an undissolved residuum of platinous oxalate.

The double oxalates are not so soluble in water as the simple salt. The oxalate baths, both of single and double salts, may be worked cold or hot (though not to exceed 150° F.), with a current of comparatively low pressure. The metal will deposit bright, reguline and adherent on copper and brass. Other metallic objects must receive a preliminary coppering as above. The deposited metal is dense, with a steely appearance, and can be obtained of any desired thickness.

The deposit obtained in the oxalate baths is sensibly harder than that from the alkaline platinate bath, and will bear buffing tolerably well.

The phosphate bath may be prepared by the following formula :—

Phosphoric acid, syrupy (sq. gr. 1·7)	...	...	8 oz.
Platinic hydrate	...	...	1-1½ oz.
Distilled water	...	...	1 gallon.

The acid should be moderately diluted with distilled water, and the solution of the hydrate effected at the boiling temperature. Water should be added cautiously from time to time to supply that lost by evaporation. When solution has taken place the same should be diluted with sufficient water to make the volume one gallon. The solution may be worked cold or warm to 100° F., and with a current much stronger than that required for the platinates and oxalates. The ammonio- (and sodio)- platinic phosphates may be formed from the simple phosphate by carefully neutralising the solution of the phosphate with ammonia (or soda), then adding an excess of phosphoric acid, or enough to dissolve the precipitate formed, and an additional quantity to ensure a moderate amount of free phosphoric acid in the bath. The phosphate baths will be maintained of normal strength by additions of platinic hydrate, the solutions of which will have to be assisted by heating the bath, preferably at the close of each day's work. The metal yielded by the electrolysis of these phosphate solutions is brilliant and adherent. It has the same steely appearance as that exhibited by the oxalate solutions, but to a less pronounced degree. The physical properties of the deposited metal are in other respects like those described in connection with that obtained from the oxalate baths.

## THE PROGRESS OF ELECTRICAL TRACTION.\*

By Dr. LOUIS BELL.

THE beginning of electrical traction, or rather of its possibility, dates from that magnificent discovery of the reversibility of the dynamo, a discovery that, perhaps, cannot be ascribed to any one person or to any definite year; it was in the air during the sixties, as the telephone was in the succeeding decade; but it was not until 1873, at the Vienna Exhibition, that the possibilities of this discovery were realised. Nothing came of its except occasional applications until Dr. Werner Siemens saw all the possibilities of the motor for railroad use, and in 1879 the first modern electric railroad was built at the Berlin Exhibition. Here for the first time a moving motor was supplied with power from a distant dynamo. The current was led to the motor car through a third rail and back to the ordinary track. Very shortly afterward the experiments began in this country, first, perhaps, in the hands of Mr. Field, and

\* Abstract of paper read before the Scranton Science Club America, June 19th, 1890.

almost simultaneously at the laboratory of that incorrigible inventor, Edison. Two years more saw the opening of the Siemens electric road from Lichterfelde, a suburb of Berlin, into the outskirts of the city. Unless temporarily stopped, that road, the first practical electric road in the world, is running to-day.

Given an electric motor and a car, how can they be combined? This was the first question to be raised. Where should the motor be put, and how should it be connected with the driving wheels? Almost every conceivable spot in and about a car had been tried as a place for the motor—on the platform, in the car, on top of the car and under the car, in almost any position that could be named. Not until the present method of swinging the motor from the car axle, so that the armature would be at all times equidistant from it, was devised, were thoroughly practical results secured. But the great difficulty in the way of using the electric motor is one which at first sight does not suggest itself—the high speed at which the motor ordinarily runs. It has been up to the present quite out of the question to build a light and efficient motor in which the armature should revolve at a low speed; I mean by that, 100 revolutions per minute, or something of the kind. With the ordinary motors running from 800 to 1,200 revolutions per minute, it is obviously absolutely necessary to reduce the speed by some kind of gearing in applying it to a car axle; for if this were not done the speed of the car would be preposterously great. Within the last ten years almost every known mechanical means for reducing speed has been applied to the problem; belts, chains, ropes, worm-gearing and every description of toothed gear has been pressed into service, but one after another has been discarded as impracticable, until at the present nearly all electric cars are operated by plain toothed gearing. In the existence of this lies one of the difficulties that must be overcome in the future.

The first electric road utilised the rails; but for street traffic this is inconvenient, and all sorts of overhead arrangements were schemed, experimented on and abandoned. Cars running on an overhead wire and dragged by wires from the car were and are still in use. Copper tubes slotted beneath were employed in which the car dragged along a wire brush much after the similitude of a gun cleaner. Then came every description of under running trolley from a wire broom that scraped and ground along the conductor to the present smooth running little wheel.

Then another snag was encountered. After the electric current is led to the car, how can it best be conveyed to the moving parts of the motor? The ordinary brushes such as we see on the commutators of dynamos answer the purpose admirably except for one inconvenient fact, that it is necessary to run the armature of a motor in more than one direction, as when the car is on the return trip, and the copper brushes that worked admirably well when the armature revolved with them raised a blazing protest when the armature revolved against them. If I were asked what is the most important minor improvement in electric traction, I should say unhesitatingly that it is the introduction of the carbon brush that rests quietly on the surface of contact and is quite indifferent as to the direction of rotation of the commutator beneath it. Aside from these fundamental difficulties minor ones were met at every point of the construction of an electric railroad. The trolley wire is necessarily under high tension, and only after elaborate experiments was the hard bronze wire now used found and adopted. Then this very tension brings a severe strain on the supporting poles, and all sorts of ingenious devices had to be invented to sustain and equalise it. The road that runs on your streets to-day is a result of an enormous mass of inventive ingenuity applied in directions of which it is impossible in a limited time to give any adequate idea. That the success which has been attained is so great is a standing monument to the perseverance and genius that have produced it. The electric car of 1890 is a machine that is marvellously successful, and in view of what is being done in every succeeding week, it is not

too much to say that the horse's occupation in street car work is practically gone.

To-day the grinding gear wheels underneath the car constitute the most serious mechanical difficulty in electric railroading, and it should be the object of inventors to dispense with them if possible. It is possible, although it has not yet successfully been done, to build a motor of which the armature shall be directly upon the car axle, and that yet will operate with a fair degree of economy. This done and we should have a system of electric traction almost ideal in its simplicity; a single rotating armature grasped and centered between field magnets surrounding the axle, the current supplied to it from a movable contact, a switch to control it. That is all. And few people have any adequate idea of the mine of power that these same grinding cog wheels waste.

A question that is often asked is: Why is it necessary to put two 15 H.P. motors under a car of the same size that was previously drawn by a couple of mules. The question is a very pertinent one, though the answer is somewhat complicated. In the first place, it has been found convenient to run electrical cars at a great deal higher speed than horse cars, consequently to employ more power. In the second place, electrical roads operate with very heavy loads on grades that are tremendously severe, as steep as one foot in ten. All this requires still more power, but does not explain fully the discrepancy between these 30 H.P. motors and the aforesaid two mules. When we come to examine the power which is required to operate an electric car, taking the average of all day long, we find that the difference is not by any means so great. Somewhere from 3 to 6 H.P. is about the amount. A sudden spurt up a sharp grade will perhaps require half-a-dozen times this amount; and this is not disadvantageous, for a motor, like a mule, can, we see, pull very hard when it becomes necessary. But let us turn a little to experiments made with the view of answering the question I have raised. Most of our present electric cars have two motors, each with its appropriate set of gears, and it is an unfortunate fact that these two do not always pull together in the harmony that might be desired. There is a constant tendency for one or the other of them to do more than its share of the work, and, aside from this, the two sets of gears consume an outrageous amount of power, which, it should be remembered, does not go into any useful work but simply tends to heat and wear out the running parts. Experiments tried last winter in Colorado show the facts of the case very beautifully. A five-ton car operated with both motors at an approximate speed of 12 miles per hour required something like 6 H.P.; using only one motor, the horse-power required was reduced to five for about the same speed; and finally, removing the pinion from one of the armatures, so that the car was operated by one motor and only one set of gears, the power was reduced to something like  $3\frac{1}{2}$ , which, considering the load and the speed, is not at all too high. A pull of something like 20 pounds per ton is required on ordinary tracks; that is, the motors in this case were pulling 100 pounds at the rate of 12 miles per hour, which, reduced to foot pounds and then to horse-power, becomes about 3, which gives the motor that actually exerted about  $3\frac{1}{2}$  horse-power a very reasonable degree of efficiency. So the cost would not be at all bad with one motor either on the axle or simply geared. It is pretty clear that there is a disadvantage in the use of two motors except in so far as it is convenient to drive both axles for ease of ascending grades, and it is no less evident that a considerable power can easily be lost in gearings.

The possibilities of electric traction are by no means exhausted in its application to street cars. I do not hesitate to say—and I say it deliberately—that to operate an ordinary railroad train by an electric locomotive is a far simpler problem, electrically and mechanically, than the operation of street cars here on the streets. The slow speed necessary for street cars is, as I have already said, a disadvantage in that it compels us to gear down the motor. In running at railway speed no such difficulty is encountered, for the four or

five hundred revolutions per minute made by the drivers of an express locomotive is just about the proper speed at which an electric motor of corresponding power could be advantageously run. We should then be enabled to dispense entirely with the obnoxious gearing and to put directly upon the axle of the driving wheels an armature big enough and powerful enough to generate the required speed. Nor is there any practical difficulty in building motors big enough to do the work. There are plenty of 100 H.P. dynamos now running, and the increase of size sufficient to duplicate the power of a locomotive is the simplest sort of mechanical operation. I do not think there is a prominent electrical company to-day that would hesitate to take an order for a 500 H.P. machine and guarantee its performance. I certainly know of several that would be glad of the chance and would accomplish the task successfully.

There is no sort of difficulty in conveying the current to one of these big motors moving at railway speeds, for it has been established by experiment that the method of running contacts such as is in general use will work admirably up to the speed of 130 miles per hour, at which speed an electric car of respectable dimensions has been actually operated. The question, then, of using the electric motor for railway work is not a question of mechanical or electrical difficulties but of economy. It is worth while noticing that in an electric locomotive the big machines can be given an amount of care quite impossible on our street cars, for the good reason that while the street car motor is exposed to the wet and dust and dirt to an enormous extent, in an electric locomotive the whole can be boxed up inside of a clean car and given practically as careful attention by the engineer as is now possible in a dynamo operated in a central station.

Now as to the question of economy. The steam locomotive, in its present stage of development, is a remarkably successful machine. Nevertheless, it does consume more coal proportionately than is used, for instance, in the engines of a big steamship like the *Umbria* or the *City of Paris*. It burns, in fact, between two and three times as much coal per horse-power of output. This is not due to any radical defects in the locomotive, which, all things considered, is a good and economical machine, but arises from the fact that the huge engines of the transatlantic liners are condensing engines, nearly always triple expansion, while the locomotive is a simple engine of a class that has been generally abandoned for steamship use. The principal advantage that we should gain by using large electric motors supplied from a central station instead of the present steam locomotives would be a much more economical use of coal. It is safe to say that the consumption of fuel for a given number of horse-power produced by big engines in an electric station could be reduced to less than half what is now used to supply a similar amount of power in the locomotive. To offset this advantage there is the necessary loss of power in conveying the current generated to the running motor. If the length of line to be operated from a single station is great, this loss may be considerable; but it is unquestionably smaller than the gain to be made in the way I have suggested. Beside this, the electric locomotive does not have to drag around its supply of coal and water.

There is, too, a magnificent possibility of economy in the use of water power. Very many of our railroad lines follow the course of some river, winding in and out along a valley; frequently there would be an abundant supply of water-power near at hand, and under such circumstances the cost of operation for an electric road would become enormously less than for the same line operated by steam. Of course, this is under favourable circumstances, and therefore we should not lay too much stress upon it; but I think it is clear to any one who is familiar with the operation of big condensing engines that their advantage in economy over a locomotive is so great as to make it worth while to distribute the power from them, even at a considerable loss. The amount of copper line wire

necessary for such distribution is not at all unreasonably great; no greater, in fact, than the amount now used in trunk lines for long distance telephony; and there is every reason to believe that, taking into consideration all these things, an ordinary railroad could be operated by electricity at a cost less, or at least no greater, than is now incurred.

As the speed to be attained rises, electric power gains over its competitor; for a high-speed locomotive must carry an enormous amount of coal and have a boiler of prodigious capacity; while inasmuch as we do not have to move the fuel or boilers of a central station, their size is a matter of indifference. The speeds that are reached now with locomotives can be duplicated with motors without difficulty. I believe the present record for locomotive speed is 87 miles per hour, made this year on the Philadelphia and Reading Road, while last year, as I just mentioned, an electric car, small, to be sure, but at the same time running under some disadvantages as regards track, attained a speed of more than two miles per minute. In fact, economy aside, I do not see that we can set any limit to the running speed of a motor except that imposed by adhesion, the strength of the steel in the flying drivers to withstand the centrifugal force and the conditions necessarily imposed on the strength and smoothness of the track.

But this aside, let us cast a prophetic glance forward to the electric express train of the future. It may consist of a motor car, very likely pointed at the front to lessen the resistance of the air to its swift passage, and containing one or more powerful motors directly on the axis of its drivers and aggregating perhaps 1,000 H.P. as a nominal output. Following it the customary vestibuled procession of baggage cars, day coaches and sleepers of the ordinary size and number. Its only lights by night will be incandescent lamps; its only means of heating electric heaters distributed through the train; 10 or 15 extra H.P. are enough to furnish an adequate supply of heat. The track over which this train will run must be straight and smooth, not at all a marvellous track, but only such a one as the great English trunk lines possess to-day. A third rail or a strong bronze wire above will convey the current to the motors, and power for it all will be supplied by a series of stations perhaps 20 or 30 miles apart along the line. The train will start smoothly into motion, fly along the track at the highest rate of speed that is found practicable, and stop quickly and easily by applying its electric brakes. The system of distributing power can be easily converted into an automatic block system that will secure beautiful control of the trains and almost absolute immunity from collisions.

Of the possible speed to be reached I will not attempt to say much. I do not think, however, that 100 miles an hour is at all out of the question, for, as we have seen, nearly 90 miles an hour has already been made, and more than 80 is made for short distance by some of the regular express trains between New York and Philadelphia. But consider even what 100 miles an hour means: starting from New York, Philadelphia before breakfast; going northward, Boston an easy morning's run, and finally, perhaps, Chicago a night's trip. All this may sound somewhat fantastic to those of you who have not followed the electrical progress of the last year; but such developments are not only possible but probable. It is not so much a question of whether it can be done, as who will be the first to accomplish it. It may not be for a decade, but unless some strange series of fatalities shall intervene, I see no reason why many of this audience should not take frequent rides on just such a train as I have endeavoured to describe. The first attempt will surely be made ere long, and in the swift progress of electrical matters that first experiment, whether it should fail or not, will surely be followed with ultimate success. Ten years has seen the electric road pass from a plaything at which scoffers turned up their sceptical noses to an everyday necessity. Ten years more will see it pass from the street car of to-day to—who knows what?

## NEW PATENTS—1890.

9773. "A system for working punkahs by electricity." R. T. MOORE. Dated June 24.

9780. "Improvements in electric railway signals." W. J. SMITH and J. W. FOX. Dated June 24. (Complete.)

9786. "An improvement on electric incandescent lighting, called 'The non-consuming glow light filament.'" L. HENDLE and E. SCHUBERTH. Dated June 24.

9796. "Improvements in and relating to electric circuit controlling apparatus." E. R. GILL, jun. Dated June 24. (Complete.)

9797. "Improvements in and relating to electric mechanical combination locks and magnetic power equalisers." W. W. ALEXANDER. Dated June 24. (Complete.)

9814. "Improvements in apparatus for electrically firing guns." R. MORRIS. Dated June 24.

9820. "Improvements relating to electric arc lamps." J. KENT. Dated June 24.

9857. "Improvements relating to welding, soldering, brazing, and otherwise working metals by electricity, and to apparatus therefor." M. W. DEWEY. Dated June 25. (Complete.)

9887. "Improvements in electrical controlling apparatus for use in connection with torpedoes." S. DE KOJINE. Dated June 25.

9888. "Improvements in connection with electric ships, binnacle, side, and indicator lamps." T. W. WATSON and A. H. WATSON. Dated June 26.

9904. "Improvements in armatures for electrical apparatus such as dynamos, motors, and transformers." W. H. CLARKE. Dated June 26.

9917. "An improved electrical circuit closer." A. M. CLARK. (Communicated by R. O. G. Drummond, South Africa.) Dated June 26.

9956. "Improvements in heating by electricity." R. KENNEDY. Dated June 27.

9991. "Improvements in or connected with the manufacture of iron by electrolysis." T. PARKER. Dated June 27.

10010. "An electrical turn-over time glass." W. PARNALL. Dated June 28.

10025. "Improvements in electric safety fuses." W. M. MORDEY. Dated July 28.

10038. "Improvements in the electrolytic treatment of metals." A. WATT. Dated June 28.

10044. "Improvements in primary batteries and in apparatus connected therewith." Sir C. S. FORBES. Dated June 28.

10064. "Improvements in electric light fittings." T. G. MARSH and G. T. BARLOW. Dated June 30.

10076. "Improved safety connections or couplings for electric conductors." R. H. GOULD and T. GOTTSCHALK. Dated June 30. (Complete.)

10090. "Improvements in dynamo and electric motor machinery." J. A. BRIGGS. Dated June 30.

10100. "Improvements in and relating to electrical indicators." A. M. FLACK. Dated June 30.

10122. "Improvements in and relating to heating apparatus for use on electric railways." M. W. DEWEY. Dated June 30.

10123. "Improvements relating to welding, soldering, and otherwise working metals by electricity." M. W. DEWEY. Dated June 30. (Complete.) [Date applied for under Patents Act, 1883, Sec. 103, 11th December, 1889, being date of application in United States.]

10124. "Improvements in electric heating apparatus." M. W. DEWEY. Dated June 30. (Complete.)

## ABSTRACTS

## OF PUBLISHED SPECIFICATIONS, 1889

6569. "Improvements in dynamo-electric generators and motors." G. E. DOERMAN. Dated April 17. 8d. A dynamo-electric generator or motor made according to the invention consists of a cast iron tube, cast in halves, each half being bolted to the other half by means of lugs or flanges cast on the exterior of said half tubes, on the interior of each half tube and centrally located a pole piece being cast, and on the ends of each half tube a bracket or plate being cast, which may partially or completely enclose the ends of its half tube, said brackets containing half of a boss, which when the two half tubes are bolted together is bored out, at the same time or at the same setting at which the pole pieces are bored out, thus ensuring centrality of an armature to be supported between the pole pieces, the shaft of said armature being supported in journals or bushes fixed in aforesaid bosses. Around the pole pieces within said cast iron half tubes are placed exciting coils previously wound and taped, and afterwards bent or compressed in a mould or otherwise to exactly fit the curvature of the interior of the cast iron half tubes around said pole pieces, the coils being made in one, or, for convenience

in bending or compressing, in two or more sections, and one or more sections may be larger than the other section or sections in the same coil, the coils thus made as nearly as possible, except where the pole pieces are situated, filling the annular space formed between the armature and cast iron tubes when the machine is put together. 6 claims.

## CORRESPONDENCE.

## Resistance Measurements.

Under the heading of "The Accurate Measurement of Low Resistances," Mr. Eden puts forth the principle of shunting a resistance to obtain a more accurate adjustment than it is possible to obtain by means of direct alterations in the series resistance of the arm of the Wheatstone bridge as arranged. I do not remember to have seen the method described before in exactly the same manner as in the article above mentioned, but I would point out that the method used by the British Association experimentalists to compare the resistance of the rotating coil used to determine the ohm, and the concrete reproduction of that value was based on a very similar arrangement of high resistance shunts to a low fixed resistance. Also a paper was read some time ago before the Physical Society, by Prof. Fleming, if I remember aright, describing a method of making standard resistance coils based on obtaining a standard nearly correct and adjusting same by means of a higher resistance in shunt. In heavy current work the principle is also very handy, as out of 10 coils in parallel one may be made slightly adjustable to correct to temperature or current density so that the resultant value of the grid resistance remains unchanged. Since the publication of the method in the last issue of the REVIEW, I have tried it in standardising resistances to carry heavy currents and have found a Thomson rheostat of 1,200<sup>ohms</sup> very handy, the resistance of its wire being taken by the P.O. bridge immediately balance has been obtained.

Charles H. Yeaman, *Electric Inspector.*

Corporation Laboratory, Liverpool,  
July 8th, 1890.

## Electric Traction.

We notice in your last issue a letter signed F. Baines, in which, when speaking of the exhibition of our new system of electric traction, at the dépôt of the West Metropolitan Tramway Company at Chiswick, last Wednesday week, he says: "I am informed by one who was present at the trial that the runs made by the open car extended over a considerable length of track, viz., about 25 yards." On the faith of his informant's statement he then goes on to speak of the demonstration as purely a laboratory experiment, &c.

We think it right to inform the public through your columns that the line on which our new system is in operation at Chiswick, and over which the car was run on the occasion in question, is 75 yards in length. It is as long as the space available for it in the dépôt, and so far as demonstrating the efficiency of the system and indicating the speed that can be obtained, it is as good as a line a mile long. We shall be happy to invite Mr. Baines to come to Chiswick and see for himself.

For the LINEE F. ELECTRIC TRACTION AND LIGHTING  
SYNDICATE, LIMITED.

Alfred E. Stove, *Secretary.*

July 9th, 1890.

[We fail to see that a line of 75 yards in length is suitable for demonstrating either the efficiency of an electric traction system or the speed which can be obtained. Surely our correspondent cannot think that a locomotive or a steamship would be tested for efficiency or pace on a length of track like the one in question, and we fear his letter is only calculated to damn the syndicate with faint praise.—EDS. ELEC. REV.]

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## STATE CONTROL.

IT was Lord Salisbury who remarked of governing bodies deputed by the State, "they begin by being enthusiastic and extravagant, and they are very apt to end in being wooden," an observation which was then, is now, and, probably, will be true for all time. At first enthusiastic, they are actively officious and dictatorial, imposing all kinds of unnecessary restrictions, and, at last, wooden, they become afflicted with official paralysis, and reach a condition of functional impotence. Early they get in front and block the path of progress; later they get in the rear, and pull from behind.

But, in spite of all, the community cries for further State remedies, and for the appointment of more governing bodies. Though every week's intelligence brings us fresh tidings of official mismanagement and departmental maladministration, though times out of number our hopes in Government schemes have been crushed and our trust in administrative projects rudely betrayed, notwithstanding the lapse of time serves but to accumulate the evidence, month after month and year after year, is the same confidence shown in the power of officialism and the same faith displayed in the omnipotence of Government. Is the system of the Government inspection of vessels shown to lead to enormous bungling, then more inspection is insisted on. "When, after long continuance of coal mine inspection, coal mine explosions keep recurring, the cry is for more coal mine inspection. When a railway accident occurs, notwithstanding the oversight of officials appointed by law to see that railways are safe, the unhesitating demand is for more such officials." If a bridge is blown down, there is expressed a wish that the Government should institute a more complete system of inspection, and so on. "Daily we castigate the political idol with a hundred pens, and daily pray to it with a thousand tongues." Always the same unwavering trust is manifested, more government we must have, and if the department fails in its duty occa-

sionally and an accident occurs, does it not make up for its neglect to some extent afterwards by—holding an enquiry!

It is vain in these days of advancing Socialism to preach against Government interference. In so doing, we are promulgating ideas opposed to the spirit of the age. According to the new lights, the time for individuation has gone by. Men are no more to struggle on their own behalf, but to give their services for the benefit of the community at large. Rewards are to be apportioned to merits as on the good old system no longer, but a condition of things exactly the reverse is to be ordained. Those, who by indomitable energy and untiring effort have succeeded in securing for themselves a share of the world's rewards, are to be mulcted of some portion by the State, that to the idle and the worthless and the undeserving may be given what they have not earned. Capital will have no rights under the new *régime*. The men who have accumulated it, those who have been self-sacrificing enough to surrender present pleasure for the sake of future enjoyment are denounced in no measured terms by the labour communists. If the new democracy is ever established, the capitalist will receive but scant consideration at its hands.

That all the great industries of our country will be controlled by the State, is included in this nineteenth century evangel. The coal mines are to be managed by Government officials. The Government must purchase the railways, and to its monopoly of telegraphy, it must add that of telephony. It is little use showing that outside the exercise of its legitimate function of protection the Government mismanages everything it touches, or in bringing evidence to show that State departments are invariably a decade behind private enterprise. It is matter of history that the Navy officials commit errors which the merchant service avoids. In taking precautions to prevent the corrosion of plates, in providing sufficient boats for saving life in case of accident, in furnishing efficient apparatus for quickly lowering boats, and in adopting a governor

to prevent the engines breaking down, they were years behind the merchant service. In refusing to carry fresh water apparatus, and in delaying the adoption of lemon juice as a cure for scurvy until forty years after a chief medical officer of the Government had given conclusive evidence of its worth, are exhibited the delays due to officialism. The use of compound engines and high pressure steam, the Government adopted long after it had been recognised as essential to economy by the mercantile marine. Nay, more, there is hardly at the present moment a British ironclad which will steam at full speed for twelve consecutive hours without something breaking down. Daily we hear of bungling at the Dockyards and of mistakes at the Horse Guards. Whether the Government builds ships or manufactures guns the work invariably costs more than if done by private contractors. If it makes weapons for soldiers' use, or coats for soldiers' backs, the same want of foresight and extravagance are manifested; and it is the same in all Government departments. Of course the Post Office will be pointed out as a Government monopoly, conducted on mercantile principles, and making a profit. But it is not proved that private enterprise would be unable to carry the work on at less cost. The Post Office progresses owing to pressure from without. It is brought into closer contact with the public than any other Government department, and though nominally under the control of officials it is virtually managed by the mercantile community. It is not allowed to become inefficient, though its conduct is by no means above reproach. A department in which the officials spend a million and a half in two years without authority is conducted on a scale of recklessness which may well excite astonishment. But it bears out Sir Charles Fox's remark—that a Government office is like an inverted filter, into which you send accounts clean to come out muddy. Business conducted on such principles would for joint stock companies mean bankruptcy, for Government departments it means but additional taxation.

The efforts of the Government to control electric lighting manifest the same blunders as do previous attempts at industrial regulation. The purposes of the legislature being avowedly to protect individual interests and secure the public safety, we have already a number of restrictions formulated by the Board of Trade, which illustrate conspicuously the arrogance of officialism, but which are quite unnecessary either for the protection of interests or the avoidance of danger. That these restrictions seriously hamper the lighting industry is apparent to all. Divided in opinion as regards all the points on which amendment is desirable engineers may be, but on this one point all are agreed, that the regulations while unnecessary, constitute an actual hindrance to progress. Acts of Parliament, Model Orders and Regulations have been multiplied, and the confusion at the moment is so great that no one knows very well where we are; a fact, the knowledge of which may have influenced Major Cardew in no small degree when preparing his recent paper for the Institution. The fact is, the Board of Trade

officials lack practical experience of the industry they endeavour to control, and a time will come sooner or later when the great mass of their regulations and provisions will be revoked, or will be set on one side, becoming of none effect. Electrical engineers know their business better than does the Board of Trade, and officials can only advance in knowledge as fast as those actually doing the work acquire the information gained from practice on a large scale. It will be found eventually that only a small amount of regulation is necessary, all save that required to enforce the due performance of the contract between undertakers and consumers, to secure the public safety and protect rival interests being consigned to the limbo of obsolete legislation. The history of electric lighting measures, when it comes to be written, will pretty much resemble the history of others. We have first the Measure, then the period during which it is discovered to be a mistake. We have next an amendment Act, followed by attempts to work under its provisions. Finally, we have the repeal succeeded in due course by another legislative experiment in the shape of a fresh measure. So it has been, so it will be. The everlasting trial and error continues, each Parliamentary session bringing new Acts, further amendments, and fresh repeals.

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The P.O. Joke.

IN the last issue of *Engineering* there appeared an article on the electrophoscope on the lines taken up by us the week before. Not only did many of the daily newspapers extol the great invention of the day, says our contemporary, but, the editor of a technical journal, which assumes that it is in the confidence of the electrical profession, was drawn readily into the snare. It certainly will be interesting, remarks *Engineering*, to see how our contemporary will climb down; perhaps by implying that, he knew it all the time, and would not spoil the little game. We do not think it difficult to identify the journal in question, but up to now we have seen no further reference to the matter in its pages.

The Electric Tramway in Buda-Pest.

IT is gratifying to learn that this line has so far proved a great success, both from the technical and commercial point of view. Our readers will remember that the Buda-Pest electric tramway was designed and constructed by Messrs. Siemens and Halske, and it was formally opened in September, last year. During the month of April of the present year it carried 337,200 passengers, or 42,684 passengers per kilometre, the line being 7.9 kilometres in length. There were 20 motor cars in daily use, excepting on Sundays and holidays, when four additional cars were called into requisition which were attached to four of the motor cars. The city possesses a horse tramway of 45.6 kilometres length, and 329 cars, which carried in the same period 33,074 passengers per kilometre, or 9,610 less than the electric tramway. Calculating the "duty" for each vehicle, it will be found that each electric motor car carried 16,860 passengers, whereas each horse car carried only 4,584 persons in the same period. The fares on the electric tramway are considerably lower than on the other lines, yet during the month mentioned, the earnings of each electric car came to 1022.95 florins; the horse car, on the other hand, earning only 369.81

florins. These figures would show that the commercial efficiency of the electric cars is much higher than that of the horse cars, and it is explained that this is mainly due to the much greater speed (18 kilometres per hour), of the former, which more than doubles the earning capacity of the line. The proportion was even greater in May last, when 387,000 passengers were carried on the electric tramway. We have no exact figures concerning the working expenses, but we are assured that they are lowest with the electric system.

“As Old as the Hills.”  
ONE would have imagined that an esteemed contemporary, conducted in the interest of certain submarine cable companies, would have known sufficient about the testing of faulty cables to have prevented falling into the error of publishing in last week’s issue an illustrated article on “A Method of Localising Partial or Dead-earth Faults in Insulated Conductors,” as if the method described was something novel and particularly interesting. The method is as old as the hills; or, perhaps, more correctly, as venerable as insulated conductors. It would be very difficult to give an exact period to its earliest discovery; but it is ancient, very ancient. When in the old days insulated conductors in the form of core or cables were found to be faulty, this method was so simply obvious that it was used. When the core was coiled the battery wire was attached to the end and there kept as the core was run off; but in the case of the insulated wire being on a revolving drum or “swift,” there was no difficulty in making and maintaining the necessary contact. It is very interesting to observe how very frequently the electrical engineer of the present day discovers methods of doing simple things which were known years ago to the telegraph engineer. It was a pity that the method, to which we have just alluded, was not patented and brought out by some eminent firm or company.

The Directors’ Liability Bill.  
IN the House of Lords, on Tuesday, Lord Herschell moved the second reading of the Bill. He said there had been a good deal of misconception in relation to its scope and object. The Bill would not deal, and was not designed to deal, more effectually with fraud than the law at present deals with it. The purpose of the Bill was to deal with persons who make untrue statements honestly, but without reasonable ground for believing them, with a view to inducing others to invest their money, or embark in any undertaking. He admitted that some of the details of the Bill were open to criticism. It was not clear, for instance, whether promoters were within its scope, yet in many cases they were the persons whom one would really like to hit; and it was certain that persons whose names were merely mentioned in the prospectus, as the bankers who received subscriptions, or the solicitors who gave the company legal advice, ought not to be held responsible for every statement put forward by the directors. “Responsible for” were very wide, and, to his mind, objectionable words, because responsibility was a question for the law to decide. The Lord Chancellor, while sympathising with the object of the Bill, had not the slightest hesitation in inviting their lordships to reject it in its present form. Lord Bramwell presented a petition from the London Chamber of Commerce, in which the petitioners stated that they viewed the Bill with very great alarm, and expressed their firm belief that if

it passed as it at present stood, no man of means and repute would allow himself to be a director of a limited liability company. He agreed with the Lord Chancellor that if it were a question of this Bill passing as it stood he should heartily vote against it; and Lord Esher remarked that not a single line of the Bill would stand examination. Lord Herschell did not know that any legislation of the kind could safeguard reckless investors from loss. The Bill was read a second time, and referred to the Standing Committee on Law. It is almost a pity that amongst those held “responsible,” the scientific expert was not included, for many a worthless scheme has been floated purely on the strength of a gushing report from some well-known professor or expert. Our opinions on the Bill, as a whole, may be read in the REVIEW for July 4th, page 11.

Scientific Reporting.  
IT is more than probable that the report on a new incandescent lamp, to which we called attention in our last issue, did not emanate direct from the Professor who carried out the experiments, but from interested parties who placed their own construction upon the loosely tabulated figures which we have since had an opportunity of examining. Nevertheless, we feel it our duty to point out how a report, seemingly guarded, may be made to indicate almost anything that is desired, and also how careful one should be to see that the calculated results contain no errors. The new lamps, which we will still designate as those of X, were 16 in number and of five different voltages, viz.:—110, 105, 100, 92, and 80. The voltage was adjusted to give the candle-power the lamps were intended to produce, which was 16. The entire batch was then averaged, a manifestly unfair proceeding when pitting the results against 100 volt lamps of another manufacture, the watts per candle-power being given as 3·778. The Edison-Swan lamps, only four in number, were tested in the same manner, and the watts per candle-power averaged, according to the Professor’s data, 4·21. Naturally this looks somewhat uneconomical for the old lamps as compared with the new, but let us examine the tests. In the following table the working out of the watts per candle-power by the Professor appears in col. A; our own calculations in col. B.

Lamp.	Volts tested at	Ampères.	Watts.	C.P.	Watts per C.P. A.	Watts per C.P. B.
No. 1...	98·9	0·643	63·63	16	3·97	3·97
„ 2...	98·3	0·628	61·7	„	4·14	3·85
„ 3...	98·2	0·631	61·9	„	4·16	3·87
„ 4...	101·4	0·652	66·1	„	4·58	4·13
					4·21	3·95

Now 3·95 is not greatly in excess of the averaged watts per candle-power of the 16 new lamps of five distinct voltages, but if we take those of 100 volts, curiously enough, also four in number, we find the average to be 3·90. Instead, therefore, of the new filaments taking less electrical energy than the Edison-Swan, we find that they are practically alike, for naturally we must select those lamps for comparison which require approximately the same voltages to give a like illuminating power. There are other points in this report to which we could take exception, but enough has been said to show that such statements as appeared in our last issue must be taken *cum grano salis*, and we shall endeavour to keep a watchful eye on the future proceedings of the owners of X’s lamp patents.

### THE TROYES CENTRAL STATION.

WITH a flourish of trumpets the Compagnie Nationale d'Electricité (Ferranti's system) inaugurated on the 21st ult. the central station at Troyes. Mr. S. Z. de Ferranti went over from England to be present at the ceremony which was rendered rather sad by the death of an employé who was killed by a shock from a transformer which he grasped to save himself from falling down a cellar. At a meeting of the municipal council, the mayor, in reply to questions, stated that the company had strictly carried out the prefectural regulations, and that no blame was attached to them.

The station is situated in the suburb of Sainte-Savine, and the plant comprises two Babcock and Wilcox boilers, one Brasseur steam engine of 150 N.H.P., and one Ferranti dynamo giving 50 ampères at 2,400 volts. As the demand for light increases it is proposed to instal two similar groups of machines. Underground two wire conductors are employed and extend about  $4\frac{1}{2}$  miles. The cables are well insulated, and are protected by an external steel wire covering. Insulated branches are jointed to the mains, which are laid at a depth of about 20 inches in the ground. The distribution is effected at an E.M.F. of 100 volts, and transformers are erected in certain places according to the consumption; current is supplied both for public and private lighting. In the former case arc lamps of 8 ampères and 50 volts are used, and in the latter incandescent lamps, of which there are 800 already in use. Light is sold at a fixed sum per lamp hour, and each subscriber has installed a Ferranti-Borel meter modified and graduated in lamp hours. The rent for the meter varies from 1s. 3d. to 4s. 10d. per month, according to the capacity. The price per lamp hour of 10 candle is  $\frac{3}{8}$  of a penny, and for one of 16 candles about  $\frac{5}{8}$  of a penny. Those persons using the light subscribe for five years, and guarantee a minimum consumption of light amounting to 29s. per annum. The company has to pay to the town a rent of 2d. per metre of mains laid, including the return.

### THE ELECTRIC LIGHT AT THE ST. MORITZ BATHS.

THE electric illumination of watering places on the European Continent has made, of late, very satisfactory progress. The favourably known health resort, St. Moritz Baths, near Engadine, in the Canton of the Grisons, Switzerland, is about to become possessed of a very interesting installation for electric lighting.

The first step is the construction of a large central station at Silvaplana, where water power is being derived from the Julien brook, with a fall of 35 metres. From here the power for the electric lighting of the entire watering place will be conveyed over a distance of  $5\frac{1}{2}$  miles. The installation will be arranged by the machinery works of Stirnemann and Weissenbach, of Zürich, who three years ago fitted up the Hotel Kulm at the village of St. Moritz (near the St. Moritz Baths) with about 2,000 glow lamps.

The central station at Silvaplana will have, at first, a capacity of 3,000 glow lamps. For this purpose three turbines will be set up, each of 125 H.P., each of which will be directly connected with an alternating current machine, type WA<sub>6</sub>. Each of these alternating machines, at a rotation of 250 turns per minute, furnishes a primary current of 27 ampères and 3,000 volts tension, and is excited by a continuous current machine of the Ganz type,  $\Delta_2$ . The regulation is effected partly by manual rheostats (one for each alternating current and exciting machine) and there is besides an automatic current regulator with a reducer and equaliser.

The water arrangements in the mountain stream, which is very violent, will be effected on the plans of the firm Largin and Grossmann, of Lucerne. The turbines and their accompanying regulators are being furnished by the firm Rieter, of Winterthur, and the elec-

trical machinery and the transformers by the firm Ganz and Co., of Budapest.

Three prominent establishments at the St. Moritz Baths will be at once supplied with the electric light.

The Bath Saloon with 700 lamps and four arc lights.

The Hotel Victoria with 700 glow lamps and three arc lights, and

The Hotel Dulac with 938 glow lamps and seven arc lights.

In these buildings there will be set up 18 transformers, each of the capacity of 8,000 watts, which convert the primary current of 3,000 volts into a secondary current of 110 volts. Of the three alternating current machines in parallel insertion, two are to perform the normal service, whilst the third is kept in reserve.

The distance between the central station at Silvaplana and the first point of distribution (the Bath Saloon) is 4,800 metres; the total distance from the central to the most remote point to be illuminated is 5,400 metres.

With reference to the high tension prevailing in the primary leads (3,000 volts) special insulators for high tensions are being supplied by the firm Johnson and Philips, of London.

The entire installation must be complete in the spring of 1891, so that the electric light may be in action at the commencement of next year's season.

### THE ELECTRICAL CONDUCTIVITY OF AIR AND THE FORMATION OF OZONE.

MORE than a hundred years ago Van Marum observed that when an electric spark is passed through a vessel containing oxygen gas, a peculiar odour is developed and the gas becomes more chemically active; thus oxygen, which has been treated in this way, will at once tarnish the bright surface of mercury.

Nearly 60 years after this interesting discovery, namely, in 1840, Schönbein wrote calling the attention of scientists to it in Poggendorff's *Annalen der Physik und Chemie*, vol. iv., p. 616. He stated that the action of the electric spark converted the oxygen into a new body, for which he proposed the special name of ozone, a word which is derived from a Greek verb meaning "to smell."

Schönbein described many of the properties of this ozone, and, amongst them, that special property of being able to liberate iodine from potassium iodide, which has since been made the basis of a characteristic test for ozone.

Ozone is capable of effecting many remarkable oxidising reactions, and on this account has been the subject of much attention from chemists. In the early fifties it was a great *cruce*, quite a bone of contention amongst the leading chemists, who were greatly puzzled concerning its constitution; amongst others, Baumert, Williamson, Frémy, Becquerel, Marignac, De la Rive, &c., joined issue.

The exact nature of ozone was discovered by Andrews (vide *Philosophical Transactions*, 1856, p. 13). He succeeded in proving that ozone is not a compound of two or more elements, as Williamson and Baumert held, but that it is merely oxygen in an altered state, or, as chemists say, in an allotropic condition.

If a series of electric discharges be passed through dry oxygen gas, a portion of it is converted into ozone, and the change is accompanied by a diminution in bulk. Chemists explain this by assuming that three volumes of oxygen condense to form two volumes of ozone. And this theory is supported by experimental evidence, most of which has been supplied by Soret (vide *Annales de Chimie et de Physique*, series 4, vol. viii., p. 113, and *Philosophical Magazine*, series 4, vol. xxxi., p. 82; vol. xxxiv., p. 26).

Ozone can be produced in a variety of ways, thus:—  
1. It is evolved at the positive pole during the electrolytic decomposition of acidulated water.

2. It is formed by the slow oxidation of phosphorus in air.

3. It is obtained when the discharge from an electrical machine is passed through dry air, or, better still, through dry oxygen gas. The silent discharge converts a portion of the oxygen into ozone. A Siemens's induction tube is the best apparatus for this experiment.

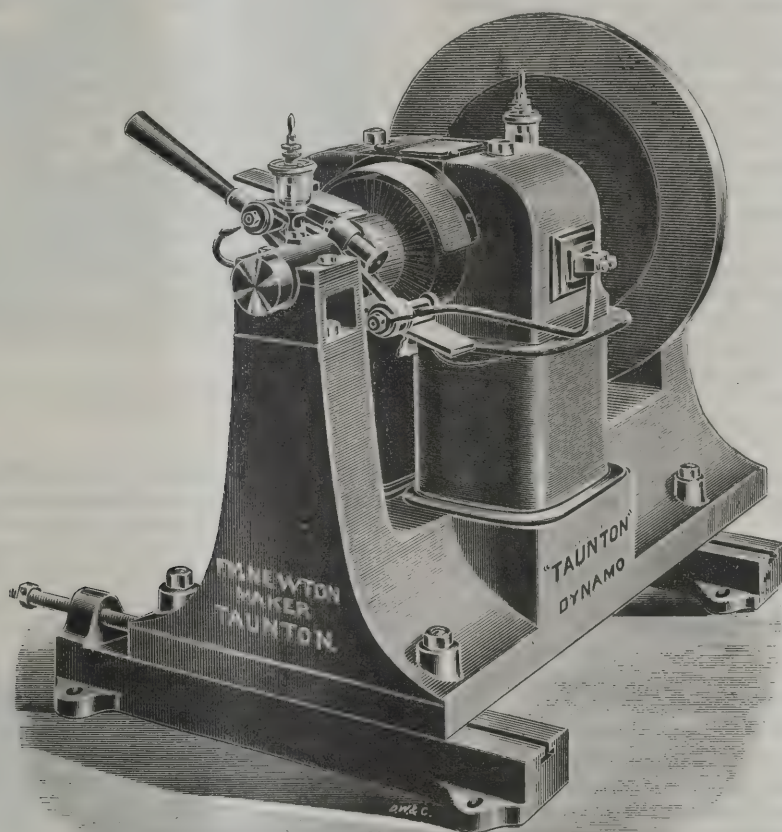
4. It is obtained by the action of a heated glass rod on a mixture of ether vapour and air contained in a beaker.

5. When a stream of air is passed on a platinum wire heated to whiteness by means of an electric current, ozone is formed.

6. It is produced during the combustion of all substances containing hydrogen in the air or in oxygen, hence it is found surrounding the flame of hydrogen, alcohol, candles, coal gas, &c.

Ozone is always found in the air which is in the

Other experiments were instituted with a view to throwing side lights upon this question, and it was shown amongst other results that the formation of solid particles of ammonium nitrite in the neighbourhood of the stick of phosphorus did not exert any appreciable effect. A curious effect was observed, namely, that the formation of ozone is hindered by the presence of oil of turpentine, and that the electrical conductivity of the air at once disappears when some of the vapour is introduced. Not only turpentine, but several of the essential oils, when acted upon by atmospheric air, transform a portion of it into ozone, and again turpentine will absorb ozone without decomposing it. These interesting results seem to indicate that there is room for still more research in this direction, which should be especially attractive to physical chemists, that is to say, to those scientists who delight in exploring the borderland between physics and chemistry.



#### THE TAUNTON DYNAMO.

vicinity of a Bunsen gas flame. Further, it is a well-known fact that air in the vicinity of such a flame possesses considerable electrical conductivity. These facts have recently attracted the attention of Messrs. J. Elster and H. Geitel, who have endeavoured to discover whether any relation exists between them. They contribute an interesting paper upon their research to the *Annalen der Physik und Chemie*, series 2, vol. xxxix., p. 321.

Suspecting that the electrical conductivity of the air in the neighbourhood of a Bunsen flame might be due to the formation of ozone, Messrs. Elster and Geitel were led to examine the electrical properties of the air enveloping a stick of moist phosphorus undergoing slow oxidation with the formation of ozone. They obtained data in their experimental investigation which enabled them to decide that the process of converting oxygen into ozone in this case, also, determined a similar assumption of electrical conductivity by the air. They were unable to demonstrate, however, that any electromotive force was connected with it.

It seems, therefore, from these experiments, that the mere presence of ozone is not in itself sufficient to impart electrical conductivity to the air, though there does seem at first sight to be some connection between the two.

THIS new pattern dynamo is of the two-pole type, built by Mr. F. M. Newton and designed by Mr. T. Hawkins. The machine has been exhibited at the Royal Show at Plymouth, where it was used to charge a set of batteries and to light Messrs. Priestman's stand being driven by one of that firm's 2-H.P. oil engines. The dynamo under consideration is shunt-wound, gives 30 amperes at 90 volts at 1,180 revolutions per minute, and runs cool on full load with an efficiency of 93 per cent.

The field magnets are made of the best wrought iron, bolted to the bed plate where the cross section has been increased, and the armature has one layer of wire wound drum fashion. There are only two turns of wire per commutator bar.

There is no lead to the brushes, and the work can be increased 50 per cent. above full load without sparking; in fact, there is no need for a rotating brush holder, and the makers intend discarding it unless specially ordered.

The machine is well designed and the bearings are long, fitted with white metal, and have sight feeding lubricators. These machines are being made in different sizes from 1 unit to 30; machines larger than this are of the four-pole type designed by Mr. Newton.

## THE ELECTRIC LIGHT AT DRURY LANE THEATRE.

### INCREASED SAFETY.

AT the annual meeting of the Drury Lane Theatre proprietors, held last Friday in the saloon building, under the presidency of Mr. Cornelius O'Dowd, Mr. C. J. Phipps, the architect, presented a report with reference to the condition of the theatre, stating that during the year there had been an installation of the electric light throughout the building.

The Chairman, in moving the adoption of the report, stated that although the institution of the electric light in the building did not bring any money into the pockets of the proprietors, they considered that it added very much to the safety of the theatre, and they therefore felt themselves justified in undertaking a moiety of the expense, the agreement with Mr. Harris being that he should pay half the expense of the electric lighting. In explaining the accounts, Mr. O'Dowd said that during the past year they had paid £1,260 for the institution of the electric light, their contract with the lessee being that he should pay half of that on the completion of the work, but as the work was not completed at the time the accounts were made up, his payment in respect of it had not yet been received, and therefore was not credited in the accounts. The proprietors would have to pay down in all about £350 more in respect to the electric light and the lessee. Mr. Harris would contribute one half. He (Mr. O'Dowd) would like to say that in addition to the establishment of the light on the stage and the auditorium, they had had it put up in other parts of the theatre.

Major Sharpe, in seconding the motion for the adoption of the report, said that he looked with much satisfaction upon the installation of the electric light, as he considered it added very much to the safety of the theatre.

The report was unanimously adopted.

## THE ZIGANG POLYPHONE.

IT is well known, writes M. Ed. Hospitalier, in *La Nature*, that the vibrating plate of a telephone may be made, under the influence of undulatory electric currents, with the necessary graduations and modulations, to reproduce all the sounds and the tones the most diverse in a gamut of the most extended scale, with only the slight and almost imperceptible alteration which is due to the fundamental sound of the vibrating plate itself. This will not be the case if we make use of the plate to modulate the current. We have already had occasion to describe M. Zigang's electric trumpet, in which a current being periodically interrupted by the vibration of the plate produces a continuous sound of peculiar tone. This electric trumpet constitutes an apparatus midway between the telephone and the electric bell, for which latter it may be substituted with advantage in a great number of cases. The first of M. Zigang's trumpets were somewhat disagreeable in sound, and the pitch was often ill defined. By rearranging the whole system with entirely metallic fittings, by suitably modifying the thickness of the plate, its diameter, peripheric mounting, the armature mass, the capacity of the resonator, and the proportions of the electro-magnet, the sound was perceptibly improved. It acquired a tone approaching to that of the hautboy, one which could be modified to considerable extent by a well arranged combination of the various organs contributing to its production. But M. Zigang aimed at something more. He aimed at transforming the monophonic trumpet, which was only capable of a single, with a perceptibly uniform, pitch, into a polyphone, or a single apparatus capable of

emitting several well defined notes. He succeeded in this by turning to advantage the connection existing between the pitch of the principal sound furnished by the vibrating plate and the diameter of the latter. The following figures illustrate the principal dispositions of the apparatus, as well as the mode of putting them in action.

The polyphone is no more than the original trumpet formed out of an electromagnet (fig. 1) mounted in front of a vibrating plate, to which a soft iron arma-

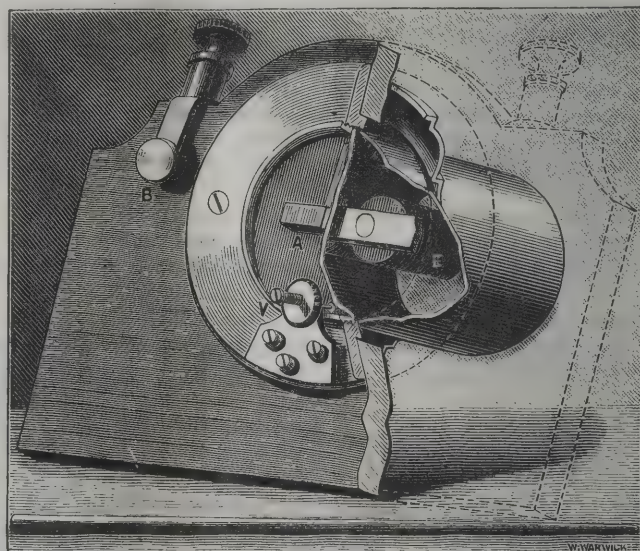


FIG. 1.—ZIGANG'S POLYPHONE.

ture, A, is attached. A platinum contact, V, closes the circuit of a battery upon the electro-magnet, and breaks it as soon as the plate is attracted, in order to establish it anew when the plate has recovered its initial position, and so on. The sound which is thus emitted is that corresponding to the natural vibration of the plate under

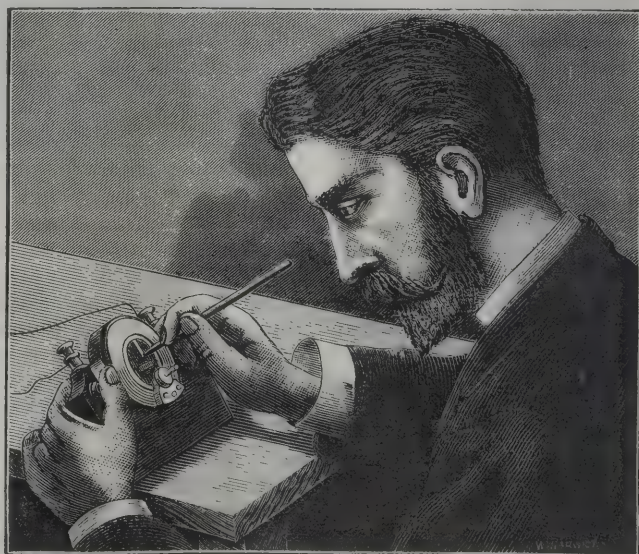


FIG. 2.—EXECUTION OF A MUSICAL AIR ON THE POLYPHONE.

the influence of the periodical creation and suppression of the currents traversing the electro-magnet. But by applying a blunt point to the plate we immobilise the entire portion of it comprised betwixt the periphery of the plate, which is fitted to the mounting, and the concentric circle which passes through the point touched. The plate thereupon emits an acute sound, which is the more acute as the point touched is nearer the centre. By touching different parts of the plate it may be made to

emit different sounds with a certain correspondence between the tones and half-tones of the chromatic scales; so that it is possible to obtain real music. This M. Zigang actually did, although the entire extent of the instrument was no greater than an octave. Each note is struck by pressing a contact button, B (fig. 1), with the left hand, whilst with the right we manœuvre the blunt point upon the surface of the plate. The connected movements are particularly facilitated by means of this instrument, upon which the inventor has already played several pieces arranged for it and for the piano. It would be possible to add to the apparatus special dispositions allowing of the easy realisation of the *forte* and *piano* notes. This might be done by introducing variable resistances into the circuit, either by varying the number of the elements by means of a commutator or by introducing into the circuit an iron-cored coil so as to modify the circuits coefficient of self-induction and thus enfeeble or enhance the intensity of the sounds at will. But it must not be lost sight of that the pitch of each fundamental sound is a function as well of the electric source and the interpolated resistances; so that the position of the contact corresponding to a note of given pitch is not always the same, but varies with the intensity of the sound obtainable, and which fact renders the performance somewhat complicated.

Nevertheless, M. Zigang's polyphone is an original and diverting instrument, and it has appeared to us worthy of being presented to our readers, if only because of its simplicity and of the experiments which it enables us to make for the purpose of imparting and demonstrating not a few of the principles of musical acoustics.

## PROF. LODGE ON THE THEORY OF THE ELECTRIC WELDING PROCESS.

By S. ALFRED VARLEY.

IN the columns of *Industries* of June 27th, there is a communication from Prof. Lodge which purports to be of the nature of a reply to recent articles of mine which have appeared in the *ELECTRICAL REVIEW*.

It is not without significance that Prof. Lodge should have preferred his comments to appear in a journal, many of whose readers will, in all probability, not have read my articles.

Prof. Lodge lays stress upon the fact that when two iron bars are welded by electric alternations, the circuit is completed in the first instance through a small section of iron only, such section becoming gradually increased, as the heat electrically developed renders the iron soft enough to be forced together mechanically, the whole section eventually being brought into electrical contact. I directed attention *more especially* to what was observed when a solid cylindric bar of iron was heated between the jaws of the electric welder, as will be seen from the following passage which appears in my published criticism of Sir William Thomson's paper on Lord Armstrong's accidental experiment:—

In the course of these experiments iron bars of as large a diameter as  $1\frac{1}{2}$  inches were welded, and *cylindric iron bars* of various diameters were heated to a white heat, a rectangular frame of cylindrical iron, forming a continuous circuit, was also placed in the jaws of the welding machine; this arrangement was something like a Wheatstone's balance, there being two paths for the current, which became divided through two arms of unequal resistance, the shorter conductor being only a few inches in length, and the longer one, say, four feet. The object of this experiment was to show that under such conditions the whole of the current practically passed by the shorter route, which became raised to a white-hot temperature, the longer one being grasped in the hand of a workman all the time the experiment was being performed.

Both Sir William Thomson and Prof. Lodge have assumed responsibility in respect to the development of the newer theory, and I invited them, on public grounds, to refute the *main* contentions of what I had brought forward, if they considered them to be erroneous. In my criticism on Sir William Thomson's paper, one of my contentions was, that what was seen to occur, when solid iron bars were heated in the electric welder, did not suggest in any way a crowding of the currents in the outer skin of the bar heated. According to the newer theory, when the iron frame forming a continuous circuit, referred to in the quotation, was placed in the welder, as the passage of the electric alternations through the mass involves overcoming inertia, the currents should have been crowded into the outer skin only, the central portion remaining "stolidly inert;" and further, seeing that the energy transmitted by the transformer was great enough to heat the section throughout to a white heat, if Sir William Thomson's explanation of Lord Armstrong's accidental experiment be the true one, then the outer skins of the two electrical paths through which the currents were being divided should have been too highly heated for the human hand to grasp.

In the article which has drawn forth this communication, Prof. Lodge has confined his comments to the electrically heating two iron bars forced together mechanically, and I cannot help thinking he has done so, because what then occurs is somewhat more complex, and therefore lends itself more readily to argument.

In the course of my articles, from common sense developments of older theory and direct observation, I have built up what I consider to be a very complete structure, every part of which harmonises with those well ascertained laws that are recognised by physicists generally.

The test we have a right to demand is that all developments of theory should harmonise with established laws, and render clearer what was known previously in part.

What led me in the first instance to oppose a theory, our mathematicians claim to be so great an advance forward, was the fact that it neither harmonised with, nor did it help us to more clearly understand, previous observations. I, myself, have reason to be thankful for having realised in my youth that two great principles—viz., harmony and continuity run through all physical phenomena, and any claims I may be considered fairly to have, either as a discoverer or pioneer of scientific advances, are attributable solely to a clear recognition that physical phenomena are all of them connected with one another, and that therefore one should suspect the truth of anything put forward, however plausible at first sight it may seem to be, if it does not harmonise with our *commonest* everyday observations. Those who really love knowledge for its own sake, and who find a pleasure in mastering the principles underlying all physical science, have often an intuitive feeling of the direction in which truth lies, and the discoveries they make are seldom accidental, they not uncommonly see truths a long way ahead, which they can look forward to realising, it may be years later, if only they are not in the meantime anticipated by some one else; but in these days of so-called advanced ideas the great thing sought for in public scientific lectures and presidential addresses is the sensational, something out of harmony with our humdrum everyday experience, and the more sensational it is, and the more it lends itself to argument, the more it is liked by the scientific talker who reaps a harvest of reflected glory by retailing and trumpeting the sensational utterances of greater men to audiences only too ready to be astonished and amused.

Those whom Society permits to make sensational presidential addresses are almost invariably men of distinction, having a deservedly recognised official scientific status, and, if criticised, the orthodox proceeding is to fall back upon professorial caste, and professional etiquette; should this fail, the arts of sophistry are commonly had recourse to, and exhausted.

In what I have published from time to time, since the Dr. Mann lectures of Prof. Lodge were delivered, I have traced the connection between a whole series of physical phenomena which mathematical physicists have regarded separately, and dealt with, as though they were not in any way connected. In this way I have been able to get round physical phenomena to some extent, and to look at them from several points of view, and, as a consequence, I feel that the position I have taken up, in respect to the newer electrical theory, is a very strong one. I go further than this, for I venture to express the opinion that both Sir William Thomson and also Prof. Lodge are well aware it is so.

The accumulated observations of a life largely devoted to scientific research has resulted in the development of a very simple theory, which, among other things, has enabled me to explain, in a natural common sense way, what at first sight seemed anomalous in Prof. Lodge's "Alternative Path Experiments." According to my theory, performing a physical act involves the overcoming of inertia—the overcoming of inertia involves a transformation of energy, and every transformation of energy involves a storage of energy in matter to the extent that inertia has been overcome. It will be found that by this simple theory all physical phenomena can be connected together in a continuous chain, and that they can all of them be traced back to a simple duality—viz., active or positive energy, and inertia or negative energy. The active energy is external to the matter acted on, and when it becomes associated with matter such association is a more or less unstable one. Negative energy, on the other hand, is inseparable from matter under all known conditions, and is the most characteristic feature of matter—viz., inertia or weight.

In all physical acts or transformations of energy, for they are convertible terms, the positive and negative energies concerned are necessarily balanced, similarly as is the case in electrical phenomena, and whenever a transformation of energy occurs, the transformation in some cases results in a temporary association of positive energy with the negative energy of matter only, and in others there results a more or less stable combination. As a case in point, interpose a copper conductor in an active dynamo circuit, a certain amount of energy then becomes transformed into magnetism at the time the circuit is closed, and energy will also be transformed into heat, the energy transformed into magnetism remains statically occluded all the time the circuit is complete, but the energy transformed into heat is only temporarily and unstably associated with the matter of the conductor in which it is developed; in fact, in some cases, as fast as energy is being transformed into heat it passes out of the conductor by radiation, and in other examples, such as electric welding, the heat becomes transformed and stored faster than it can escape by radiation, and in such cases there is an unstable association of positive energy with the matter of the conductor.

The transformation of energy into heat in an electric circuit is dynamic, whereas the transformation of energy into magnetism is a statical occlusion, and in all cases where positive energy becomes combined with matter, forming a more or less stable combination with it, the positive energy is statically occluded.

When a copper electric circuit is divided, the energy which was transformed into magnetism and statically occluded at the time the circuit was closed, is parted with *completely*, the copper conductor passing from the magnetically polar to the normal condition very rapidly, and the energy which remained occluded all the time the circuit was complete, becomes now dissipated through the medium of current developed during the act of demagnetisation. If an iron conductor be interposed in a dynamo circuit, the transformation of energy into magnetism that then occurs will be enormously greater than when a copper conductor is interposed; but when the circuit is divided, the energy transformed and occluded as magnetism will be parted with much more slowly than was the case with the

copper conductor, and some of it will be retained; the iron conductor, unlike the copper one, remaining more or less permanently magnetised; and here we have an example of a more or less permanent combination of positive energy with matter.

A plating bath is an example where no storage of energy occurs, or, to speak more correctly, where no work is done beyond that involved in overcoming conductive resistance, energy is certainly unlocked at the anode to the extent that the anode is broken down; but it becomes transferred to the cathode, where it builds up a structure the equivalent of that destroyed at the anode. In the case of a storage battery, where lead is oxidised, or a low oxide is converted into a higher oxide, altogether new structures are reared, and a very large transformation of energy occurs, the energy transformed becoming statically occluded in the new structure produced, which, being a very unstable edifice, readily parts with the positive energy entering into its structure whenever the conditions are at all favourable for doing so. Structures such as those developed in storage batteries are fairly comparable to fulminating compounds, which are simply very unstable structures, having relatively to their mass a very large amount of positive energy unstably occluded. From fulminating compounds we may pass to organic matter, such as wood or coal, and from organic matter we pass on by easy stages to such metals as gold or platinum, which are very stable structures, and not readily broken down.

The cases cited are a few illustrations of the way physical structures, and the forces associated with them, are all of them connected, and the simple theory developed by me, and published in the columns of this Journal, will be found to join them all in a natural, common-sense manner.

The most unstable association of positive energy with matter is undoubtedly a statical accumulation in a Leyden jar, and the next in order to this is a statical occlusion of energy in the form of magnetism in a copper conductor closing an electric circuit, for in both these examples there is no affinity between the positive energy and the matter it is associated with, the accumulation of energy being maintained solely by pressure.\*

Now let a mechanical illustration be briefly considered. (1.) Suspend a block of wood by a long string, and set it swinging by the hand; the whole of the energy imparted to the block in this way will practically take the form of motion, and it will be eventually, but slowly, parted with in the form of heat. (2.) Strike the block with a mallet and a percentage of energy will be at once converted into heat; but the greater percentage of energy transferred to the block will still probably be in the form of motion. (3.) Fire into the block a rifle bullet whose weight, multiplied by the square of its velocity, equals that of the mallet, and assume the bullet becomes buried in the wood, very little motion will be imparted to the block, nearly the whole of the energy associated with the bullet becoming transformed into heat.

Now let us consider what occurs when a Leyden jar discharges through an air space and a metal path. Energy accumulated as statical charge may be fairly regarded as a projectile unhampered by weight, whose speed under mentally conceivable conditions is infinitely greater than that of any rifle bullet, the time occupied by a Leyden jar in discharging being determined *solely* by the conditions that prevail in the path of discharge. Energy in the form of a statical electrical charge requires a path much in the same way as a fluid does, and space devoid of matter opposes as impenetrable a barrier to its passage as a solid mass of metal does to the flow of water; the path of discharge consists of an air space and a metal conductor, and as there is a great deal more matter in the metallic conductor than there is in the air space, and as inertia increases as the mass, it is in the metallic portion of the

\* The rate at which a copper circuit demagnetises, is determined by the conductive resistance of the circuit.

path that inertia is chiefly encountered, and where the transformation of energy mainly occurs.

The vehicle of transmission of a Leyden jar discharge is the electricity of the path itself, and if due allowance be made for the fact that neither energy nor its vehicle possess weight, then it will be found that a Leyden jar discharge comports itself in respect to metallic conductors very similarly to that described in reference to the mechanical illustration. In the mechanical illustration a much larger percentage of the energy was transformed into heat when the bullet was fired into the wood, than was the case when it was struck with a mallet; and so, also, a much larger percentage of the energy of a Leyden jar discharge, if of very high potential, becomes transformed into magnetism developed in the metallic conductor than would occur if the same amount of energy were statically accumulated in condensers having a much larger surface than the Leyden jar, and in which case the potential of the energy, and the rate of discharge through the paths, would be greatly reduced.

I have in previous articles emphasised the fact that the energy of a static charge is a limited quantity; and if I am right in maintaining that overcoming inertia in a metallic conductor is simply a transforming of energy into magnetism, then it follows as a truism that the greater the mass in the conductor the larger the percentage of the energy that becomes so transformed; and, further, that the magnetism developed, however large the conductor, can only approach to, but never exceed, the total amount of energy accumulated in the Leyden jar.

If only the continuity which runs through all physical phenomena be recognised, I think it must be seen how naturally what is observed in connection with Leyden jar discharges through metal paths falls into its proper place.

With the assistance of the newer development of electrical theory, Prof. Lodge has not been able to give a clear and intelligible explanation of his own "alternative path" experiments. My theory, on the other hand, not only explains Prof. Lodge's recorded observations in an understandable manner, but they become so plain and simple, that I have felt myself warranted in predicting that certain results will be obtained, if the alternative path experiments be repeated under certain conditions which I have specified. Now, if I can not only explain, but can also predict, where mathematicians cannot even explain, then it follows that my simple theory is a much more serviceable one than a complex theory, demanding the highest mathematics for its development.

My theory has been developed from direct observation and common sense reasoning, and I have shown in the course of my articles, that it has a much wider application than simply dealing with the experiments exhibited in connection with Prof. Lodge's lightning conductor papers. I have analysed inertia, which, as far as I know, no other physicist has ever even attempted to do. I have also, in no small degree, analysed the composite phenomena grouped together by mathematical physicists under the common term self-induction, and I have dealt also with the phenomena covered up by the term hysteresis.

In the analysis I have given of self-inductive phenomena, I have limited the term self-induction to the mutual induction between magnetised molecules on one another, and in my criticism of Thomson's paper on Lord Armstrong's accidental experiment. I called attention to certain matters in connection with electric welding, which I said I considered mathematicians could fairly claim as qualifying what was observed, and I pointed out that as iron loses its susceptibility to magnetism at a red heat when iron is raised to such temperature, the magnetic induction between molecule and molecule should cease, and therefore the inertia resistance opposed to rapid alternations in the direction of the electric currents should become very much reduced when a bar of iron in the welder reaches a red heat. Now I believe I am the only one who has pointed this out, and I was able to do so because of the

analysis I had made of the self-inductive phenomena which occurs in closed electric circuits, and which, as far as I know, no mathematical physicist has ever attempted to make. I am sorry to have to say it, but Prof. Lodge seems to me to have taken advantage of what I am the only one, I believe, who has called attention to, without giving me the credit for it, but the giving me credit for the accomplishment of scientific work is what certain of our physicists find it so difficult to do. I have not been trained in the orthodox schools, and I seem to be considered out of the pale of sectarian scientific salvation. The gist of Prof. Lodge's comments, which appears in *Industry*, relates to the reduction of self-induction which I suggested (in my criticism of Sir William Thomson's paper) would be found to occur after the iron bars had reached a red heat, but which *has not yet* been verified by experiment.

I venture to express the opinion that the newer development of theory is fundamentally unsound. Maxwell, its originator, has been credited with having successfully reduced all electric and electro-magnetic phenomena to stresses of the ethereal jelly; in other words, to stresses of a hypothetical entity, of whose existence there is no *real* proof, and therefore the ultimate basis of the newer theory is hypothesis pure and simple.\*

I cannot help thinking that some of our mathematicians would do well to take to heart the story handed down in reference to Archimedes. Archimedes undertook to move the earth, if only a base outside it were given him; the base he required was not forthcoming; that being so, we may be very sure he never wasted his time attempting to move the earth. Mathematicians, be they ever so able, can no more build up sound theory without an absolutely sound basis, than Archimedes, in the absence of a base, could move the earth. At the risk of being considered dogmatic, I venture to go further than this, and to express the opinion that the basis of all man's theories must be a material one, that is to say, the basis of theory must consist of direct observations associated with matter. We know just a little about matter and the forces associated with it, and no more, and what we do know has been learned from observation. Sir Isaac Newton never attempted to define gravity, he simply observed gravity's laws, the dogmatic utterances of Nature, and these utterances, *not* hypothesis, gave him a basis *absolutely* sound, which his mathematical ability was able to turn to splendid account. The great work associated with Joule rests ultimately on direct observation, and the same can be said of the mechanical theory of heat, whose basis was the observation, that when atmospheric air or other-gas performed work in the act of expanding heat disappeared. No man can explain why this is so; it is simply a dogmatic utterance, and the ultimate basis of all true science consists of the dogmatic utterances of

\* If any physicist could have evolved a true hypothesis, it will be generally admitted that Maxwell could have done so, but it passes the wit of any man to do this; the writer has a lively remembrance of the only time he had the pleasure of meeting Maxwell and discussing magnetism with him; had the writer not been aware he was speaking with the great physicist, Maxwell's large dreamy eyes and general physiognomy would have suggested the poet rather than the mathematician. With regard to the existence of the hypothetical medium, ether, the writer admits the necessity of some such assumption. As far as observation goes, no communication between matter and matter can occur, excepting through a medium, and such medium, as far as can be seen, must be of the nature of a material one. Energy, when associated with electricity, requires a path, and evidence is forthcoming which seems to necessitate a medium of some kind for magnetism to be transmitted; that being so, it seems a fair inference that a vehicle is necessary for the transmission of energy; in any case, our imperfect knowledge renders such an assumption almost a necessity; but if an attempt be made to define the nature of the medium which has to be mentally conceived, it will be found that the medium must be assumed to possess both positive and negative qualities at one and the same time, and such a conception makes as large a demand on our credulity as the Athenian Creed itself. As we cannot altogether dispense with mental assumptions, it is legitimate enough to avail ourselves of them; but the writer's contention is that it should never be lost sight that they are mere assumptions, which cannot possibly form a base on which a scientific structure can be safely reared.

Nature, which we become acquainted with only by observing. The human intellect is very limited. It is equal to observing and building up observations, but it *cannot* create; and it does not seem capable of travelling, with safety, outside the limits of matter; and further, all science, if only completely grasped, can be explained by *common sense reasoning*, which, unfortunately, school training has a tendency to cripple.

If anyone will perform the task of carefully going through "Modern Views of Electricity," which is not the easiest of reading, he will find the newer development of theory to consist of a series of hypotheses, resting upon one another, and resting ultimately on hypothesis also, and every one of these hypotheses is taken for granted as being absolutely true.

Sir William Thomson, addressing a body of engineers as their President, not only told them that electric alternations were confined to the outer skin of a conductor, but he told them the actual depth they would enter under conditions he specified; in this address Sir William overlooked altogether the transformation of energy into magnetism, and its subsequent transformation into current during the demagnetisation which occurs between each alternation. I have pointed out in my articles that the current produced by the demagnetisation of a conductor is developed throughout the whole section, and is at a somewhat higher potential in the centre, and if I be right in my contention that transient currents pass through the mass of the conductor, then the energy transformed into magnetism and subsequently into current, whenever rapid alternations are transmitted, must represent a very considerable percentage of the energy.

Sir William Thomson cannot deny that the currents produced during the act of demagnetisation of an electric circuit are developed throughout the mass of the conductor; but according to the newer theory, there would be but little transformation of energy into magnetism, and, possibly, Thomson regards the current so produced as a negligible quantity, and considers that what transformation occurs between each alternation is covered by the term hysteresis. I am very sorry the word hysteresis has come into common use; I believe the term is due to Prof. Ewing, for whom I have the greatest respect, and to whom I have the best of reasons for feeling indebted. My reasons for objecting to the coining of terms is that they are too often employed to cover up problems, and to decently bury what ought to be faced. I do not want to claim more than I have a right to; but I think I have given a generally correct explanation of what occurs in a conductor when rapid alternations are being transmitted, and which the term hysteresis, as I understand it, covers, but does not attempt to explain; in any case, I have discussed the matter, and that is something.

A Leyden jar discharge through a metallic conductor is undoubtedly the most transient electric current we are familiar with, and therefore inertia phenomena should be accentuated in the highest degree when a Leyden jar discharge takes place through a metallic path. Now, I should like to ask Sir William Thomson: (1) What evidence he can produce that the transient current of a Leyden jar discharge through a conductor of large section is confined to the outer skin? (2) What evidence is there forthcoming which goes to show that electric alternations transmitted by a transformer through solid cylindric iron bars are crowded into the outer skin.

I do not think (1) that it can be a matter of contention that in the alternative path experiments the B spark arises out of the demagnetisation of the path, L; (2) that the recorded observations of Prof. Lodge demonstrate that the discharge of a Leyden jar is completed in a less time through a No. 1 B.W.G. copper wire than through a No. 19 copper wire, the section of which is 100 times less than that of a No. 1 B.W.G. wire; (3) that the B spark is greater with the No. 1 wire than with a No. 19 wire; (4) that the spark at B, being due to current developed by demagnetisation, the greater spark observed in the case of the thicker wire indicates a greater transformation of energy

into magnetism at the time of discharge, and this must be taken as demonstrating that the discharge passed through a larger mass of matter, for it seems clearly evident that if the discharge were confined to the outer skin of the conductor only, it would pass through a thinner skin in the case of the larger conductor on account of its greater surface, and the spark at B would have been less, instead of being greater, as it was found to be by Prof. Lodge.

The alternative path experiments of Prof. Lodge—explained as they are, without any straining, by my simple theory—seem to me to prove my contention up to the very hilt.

Prof. Lodge cannot possibly object to his own experiments, and I assume Sir William Thomson accepts the recorded observations of Prof. Lodge in connection with these experiments. Now I should like to ask Prof. Lodge, and also Sir William Thomson, whether I have not made a fair analysis of the "alternative path" experiments; and I would further ask these two distinguished physicists, who have assumed responsibility in respect to the newer development of theory, on public grounds, not to maintain silence. I do not like to think that either Sir William Thomson or Prof. Lodge can have any other desire than the development of scientific truth; and I ask them, therefore, to meet me frankly and straightforwardly. My main contentions are plain enough, and admit of plain answers; and I do hope, if I am honoured by criticism, such criticism will not be confined to the outer skin of my arguments.

#### STENO-TELEGRAPHY.

UNDER the name of steno-telegraphy, Mr. G. A. Cassagnes designates a new telegraphic system, founded on the combination of mechanical stenography with telegraphy.

The apparatus is an adaptation of the stenographic machine of Michela in which, by means of 20 signs and their combinations, all possible phonetic sounds can be represented. As soon as spoken, the words are, so to say, decomposed by the ear of the operator at the key-board; the graphic representation of syllables is printed in small distinct lines on a tape of paper, and there only remains afterwards to read these lines from left to right to reproduce the language spoken, whatever it be. It is stated that an operator can, after about six months' practice, stenograph from 150 to 200 words per minute in a language with which he is familiar, which is more than is necessary to follow the fastest speaker. Fifteen days are said to be sufficient to learn to read the tape fluently.

M. Cassagnes's invention has for its object to reproduce at a distant station the stenographic tape that Michela's machine produces, *in loco*, and at the same speed. The object is effected with a single wire and an arrangement of the multiplex system in which the La Cour phonic wheel plays such an important part, the La Cour method of synchronism being adopted.

The distributor with its trailing arm has 20 sectors, or groups of sectors, each corresponding to one of the 20 signs referred to.

A large number of practical experiments have been made with the apparatus on looped wires (properly arranged with earth connections), and also on direct wires with the instruments at the ends of the wires between Paris and Lille, the route followed being circuitous, and the greatest length 770 kilometres. In all cases the results are stated to have been most successful, the output of work being very much greater than that obtained on the ordinary telegraphic system.

We must remark, however, that with the apparatus arranged to work as an automatic system, *i.e.*, using perforated tapes, the maximum speed appears to have been 400 words a minute which is quite equalled in this country by the Wheatstone automatic system, with its less complicated mechanism.

**ELECTRICAL ENGINEERS AT EDINBURGH.**

ABOUT 70 members of the Institution met in the phonograph room of the Exhibition on Tuesday last to hear papers read. Dr. Hopkinson, in his capacity as Chairman, expressed satisfaction at seeing a good number of members present to enjoy the kind hospitality of the Executive Committee of the Exhibition.

At the commencement of the business the secretary announced that Sir Archibald Campbell would be pleased to see any members of the Institution at his works on the Clyde. Several gentlemen of Edinburgh were also anxious to receive members of the Institution as guests, an anxiety which would doubtless be relieved.

Dr. Walmsley read a paper on some of the chief features of the Exhibition, a subject exhaustively treated in the pages of the REVIEW. Mr. Bennett followed with a paper on "Foreign Currents in Telegraph and Telephone Lines."

In the evening the Executive Council gave their reception in the Concert Hall to the members. Several articles and scientific instruments were specially exhibited.

The meetings were resumed on Wednesday morning, Mr. W. H. Preece in the chair. The paper on "The Working Efficiency of Secondary Cells," was, in the absence of Prof. Ayrton, read by Mr. Lamb, one of the joint authors. A discussion followed, which we shall publish at the end of the paper, which we partly produce in this issue of the REVIEW.

After the reading of the papers, a party of the engineers and friends left in the afternoon for Queensferry, to view the Forth Bridge. The male portion alighted from the train at north end and walked over the bridge. Reaching the other side a launch was chartered which conveyed the whole party under and about the bridge. It is needless to say, the structure was generally admired.

**THE TELEGRAPH CLERKS AND THE  
NEW SCHEME.**

WITH a praiseworthy alacrity which has probably astonished even their best friends, and which is generally considered foreign to the deliberations of that administrative body, the Lords of the Treasury have considered, sanctioned, and returned to the Postmaster-General the recommendations submitted to them by him, and which have for their object the general improvement of the position and prospects of telegraph clerks in the service of the Crown.

The provincial readjustment has, it is stated, given satisfaction in various quarters; but it would be premature to judge of the general feeling at so early a period, more especially as its application has yet to be effected. We may, therefore, take the reported provincial approval as being at present largely prospective. Dealing with the proposals which immediately concern the numerous and ever-increasing staff at the Central Telegraph Department, London, we find that the Postmaster-General's offspring has been presented to them without a head. This has probably got knocked off, or, as the official phrase has it, been "delayed in transmission"—whether designedly or not, we cannot say. But the fact remains, and, to put it in a simple way, it is a column lacking its most interesting and characteristic feature—namely, its capital.

We cannot but admire, as we are sure all telegraph clerks will appreciate, the thoughtful, considerate, and, we feel inclined to add, generous spirit with which the base and trunk of the Postmaster-General's work have been invested.

In this direction we observe that where leave cannot be granted on Bank Holidays, extra pay will be awarded. The official intimation of this, as of several other points in the scheme, is vague and

ambiguous to a degree. This may be due to hasty drafting, together with a desire to give immediate information to the staff; at all events, it is to be hoped that it has not been intended as a suitable adjunct to the missing "capital," to which we will refer more fully hereafter.

The ambiguity of this document is probably also the cause of the more important announcements contained therein being received with, as we hear they have been, dissatisfaction and distrust.

Another generous concession, and one for which telegraph clerks will not fail to heartily thank the Postmaster-General, is that all overtime shall be paid for at what is known as "rate and a quarter." Knowing as we do that through a heavy—nay, almost a necessitous and often unforeseen—demand on the one hand, and, generally speaking, a ready response on the other, much extra time has to be performed, we cheerfully recognise both "just and generous" consideration here. This, and the Bank Holiday arrangement, will be common to the whole service.

Provincial clerks will be paid overtime for Sunday work, an emolument always given to London men. In a somewhat uncertain manner it is stated that annual leave will remain as before, and we accept this as meaning that clerks receiving £150 per annum and upwards will receive one calendar month's leave.

There is a reasonable possibility that clerks, in a scale which extends to £160, are entitled to the same period.

The leading features of the scheme, however, are the monetary reforms.

Clerks in the second class will, after a period of probation, say, about two years, go from £45 or £46, by £6 per annum, to £110—old maximum £100, by £5—£110 after 14 years' service; certainly not a dazzling prospect! 1st class, £110 to £160, by £6, an increase of £20 on old maximum. We find that a first-class clerk will have served 22 years and upwards for this sum, unless in the earlier stage some encouragement, in the shape of double increments, is forthcoming. We do not think him likely to appreciate his position, and for reasons which will require little explaining.

We have already said that the Postmaster-General's column lacks its capital. The official announcement refrains from holding out any prospect whatever as to a first-class clerk's promotion to the senior class. The case of the senior class, as at present constituted, is under consideration, and the most adverse rumours are in circulation. Many first-class clerks, who have been told that they are "worthy of every encouragement," have already been waiting two, and in some cases, nearly three years at the top of their class at £140. They have seen colleagues with no more, and a few with considerably less service promoted to the next or senior class. These latter will attain Mr. Fawcett's maximum of £190. The former, who had been contemporary with them, through being what is officially termed "unlucky," will, after 25 years' service and upwards, find themselves in receipt of £160, and with absolutely no prospect beyond that figure held out to them. The Postmaster-General's decision with reference to the scheme is the "capital" to the "column." His decision being withheld, though even briefly, robs his labours of what should be their crowning glory. We can see here why the staff have a dislike to receiving schemes by instalments. It is to be hoped, in the interests of the public service and also of its servants in the Telegraph Department, that a fair and free prospect of at least attaining Mr. Fawcett's maximum of £190 or, better still, £200, will be given to all meritorious and deserving men.

As we have already said, much in the Postmaster-General's scheme commands our unqualified praise, and we recognise therein consideration and even sympathy for the more ordinary privileges and comforts of the telegraph clerks as a working body both in the concrete and the abstract.

The delay in dealing with what we have termed the "capital" question will be happily incurred, provided it results in what we trust will be a just and liberal

recognition of the claims of the hundreds upon hundreds of telegraph clerks who are anxiously and earnestly awaiting the creation of what is commonly known as a "reasonable prospect." Such a step would, we feel assured, set the seal to the Postmaster-General's work, his reward would be found in the spread of a gradual, yet, nevertheless, general and abiding contentment throughout the service, agitation would have only one object—to languish and die—the lack of cheers and excess of jeers of which we have heard far too much on recent occasions—as we have also of the "violent assault" case, to which we merely refer, and which has, we imagine, been distorted and exaggerated beyond all reason—would give place to a hearty and earnest union of interests, tending to the advantage and satisfaction of the public, and the commercial success and progress of the telegraph service, throughout the country.

## NOTES.

**Newry and the Light.**—The Town Commissioners have refused their consent to the application of the Irish House-to-House Electric Light Company to light the city.

**Sheffield Lighting.**—A special meeting of the Town Council has been called to consider applications by electric lighting companies. The *Sheffield Independent* suggests that the council should itself apply for powers.

**Weymouth Lighting.**—Messrs. Latimer Clark, Muirhead & Co., London, intend to apply to the Board of Trade in the next session of Parliament for a provisional order to supply electricity in the town.

**Proposed Electric Lighting at Worthing.**—The Laing, Wharton and Down Construction Syndicate, Limited, notify their intention of applying for a provisional order enabling them to supply the electric light within the jurisdiction of the Corporation of Worthing. The local authority has referred the subject to a committee, who will recommend whether the application shall be assented to or opposed.

**Competitive Electric Lighting at Southampton.**—Several companies are in the field anxious to obtain the necessary orders to enable them to supply the electric light within the Borough of Southampton, among them the South of England House-to-House Electricity Company, the Electric Installation and Maintenance Company, the Southampton Electric Light and Power Company, and the National Electric Supply Company. The Town Clerk has written to these rival companies informing them that it was not at all probable that the Corporation would assent to their applications; and the House-to-House Company has replied that in the event of the Corporation deciding to undertake the supply of the electric light, it would not proceed with its provisional order, but offer the Corporation every assistance.

**Electric Lighting at Brighton.**—At a special meeting of the Brighton Town Council on Thursday, contracts for the erection of buildings for an electric light generating station and for other works, were ordered to be entered into forthwith. Alderman Ewart said that the electric lighting scheme was the beginning of an enterprise which would make Brighton more popular than ever. The sooner every hotel, lodging house, and the important thoroughfares were lighted by electricity, the better it would be for the town.

Pertinent questions are being asked with reference to the tenders for supplying the electrical plant in Brighton. In one instance, that of dynamos, the highest tender was £11,946, and the lowest £6,975. Why this difference queried Col. Tester? It is also suggested that the successful contractors were unduly favoured by the Lighting Committee's engineer.

**Exeter and the Electric Light.**—There was a discussion at the last meeting of the Exeter Town Council, anent the desirability of the corporation undertaking to supply the "light of the future" to the inhabitants, instead of allowing private companies to establish a monopoly in the city. The Devonshire Electric Light and Power Supply Company, Limited, has given notice of its intention to apply for a provisional order, and in view of this, it was decided to appoint a committee to consider the desirability of the corporation taking steps to obtain the necessary electric lighting powers.

**Berlin Lighting.**—Notwithstanding the satisfactory arc lighting in the Kaiser Wilhelmstrasse and the Unter den Linden, it is not, says the *Electrotechnische Echo*, intended to extend the public electric lighting for the reason that the perfection of gas lighting produced by competition is expected to give the same result with less cost.

**The Lighting of Dusseldorf.**—A central electric station proposed for the town was to have had a capacity of 10,500 lamps of 16 candle-power, but owing to the demand it is decided to enlarge the scheme to a capacity of 18,000 lamps, and new tenders are invited. Most of the tenders sent in were for continuous current with accumulators.

**Woolwich Lighting.**—The Woolwich Electric Company and the London Electric Supply Corporation have both notified to the Woolwich Local Board of Health their intention of applying to the Board of Trade for provisional orders to light Woolwich by electricity. A special day is to be devoted to consider the applications. There appears a disposition amongst the members of the board to favour the local company.

**Canterbury Lighting.**—By a majority of one the Canterbury Corporation has resolved that pending the granting and confirmation of the provisional order to be applied for by the council, application be made to the Board of Trade, authorising the council to supply electricity for public and private purposes within the city. If the licence be granted, it is proposed to commence operations at once.

**Electric Light at Bridlington.**—The Laing, Wharton and Down Construction Syndicate has fitted up the Prince's Parade at Bridlington with 1,200 candle-power arc lights. The lamps were working for the first time on Saturday last before a gay and fashionable assemblage.

**Croydon Lighting.**—The Corporation of Croydon has decided to apply for parliamentary powers, with the intention of selling its rights or not, as it pleases, to a company.

**Leamington Lighting.**—The worthy folks of Leamington still appear to have a very bad impression of the electric light, Mr. Crowther Davies, at a council meeting, characterising it as "eminently unsatisfactory."

**Winchester Lighting.**—Tenders are invited for lighting the city and municipal buildings by electricity.

**Breaking Telephone Insulators.**—Six Birmingham boys have been fined 5s. each for damaging wires and insulators belonging to the National Telephone Company at Smethwick. About 150 insulators were broken, and serious interruption caused to the service. Over 12,000 insulators had already been broken in this way.

**Sensational Reporting.**—In describing an accident at the Californian Electric Light Company's Works, a San Francisco reporter states that "the volts (big fellows, weighing 20 lbs. each) whizzed through the air with the velocity of cannon balls, and buried themselves in the walls of the establishment. One man was injured, though not seriously." A New York exchange suggests that he may have been hit by one of the flying volts.

**Laying of the Tory Island Telegraph Cable.**—On the evening of Wednesday, the 9th inst., at 7.30 p.m., the opposite ends of the telegraph cable between Tory Island and Pollaguill, on the mainland, were brought together and united. From that moment the long-talked-of project of telegraph communication between Tory Island and the mainland had become a reality, and the "Sentinel of the Atlantic" is now connected by telegraph with every shipping office in the British Isles. The contractors with Lloyd's for this work are the India-Rubber, Gutta-Percha and Telegraph Works Company, of Silvertown, London. The steamer *Buccaneer* was in charge of Captain D. Wilson Barker, R.N.R., the expedition being under the direction of W. H. Gray, Esq., engineer-in-charge, with Mr. Edward Stallibrass, assistant engineer, and Mr. J. Schneider, electrician. The cable is one of special construction. The shore end extends about a mile at each end, and weighs 17 tons to the mile. It has two cores and two sheathings of galvanised wire, with an outside protection of hemp cords and bituminous compound. The cores are protected against insects by brass tape. The main or deep-water cable weighs about  $7\frac{1}{2}$  tons per mile, and has but a single sheathing of wire. The underground or Tory Island end of the cable weighs about two tons to the mile, has one sheathing of galvanised wire, and has a protection of tarred cotton tape. In order to inform passing ships of the telegraph line, and as a protection against vessels casting anchor over it, one large buoy is placed over the cable about a mile south of Tory, having on it the word "Telegraph" in conspicuous letters. Nothing remains but to complete the arrangements for laying the land-line on Tory. Full directions have been given by Mr. Gray to have this work accomplished, and an officer from the Post Office is also making preparations for the erection of poles and connecting the wire between Pollaguill and the telegraph office at Dunfanaghy. By the kind permission of Mr. Gray and Captain Barker, a number of ladies and gentlemen at Dunfanaghy eagerly availed themselves of the rare opportunity of witnessing these scientific experiments in electricity, and the practical routine pursued in laying deep-sea telegraph cables, and at the same time of seeing Tory Island, and while on board the *Buccaneer* the visitors were most hospitably entertained by the officers engaged in the expedition.

**Tenders Wanted.**—Tenders for the electric lighting of Stockholm are invited, the same to be sent to the Director of Gasworks, Stockholm, by September 1st. Particulars may be seen in our advertisement pages.

**Electric Traction.**—*Money*, in announcing the formation of two more electric traction companies, says that until the traction companies agree to work by electricity a good stretch of line, nothing but experimental and commercially unsuccessful short lines will result.

**A Gaulard Monument.**—A statue to the late M. Gaulard will be inaugurated in the course of the month at Lanza, Turin. Gaulard will be represented crowned with laurel and oak leaves, and at his feet will be sculptures in low relief, emblematical of his achievements in the domain of electricity and of his untimely death. The monument is by Cesare Biscarra, of Turin.

**The Electric Welding Company.**—The *Stock Exchange* understands that this company, when brought out, is likely to be attacked by the electrical papers on the ground of over-capitalisation. Our contemporary is not far out in its calculations.

**Electric Traction in the States.**—The Spring Garden Avenue Street Car Line, of Pittsburgh, is going to be turned into an electric road.

**Personal.**—We have received an intimation that Mr. John Pearce has commenced business as an electrical engineer at 182, West Regent Street, Glasgow.

**Secondary Batteries.**—The paper on "the Working Efficiency of Secondary Cells," by Messrs. Ayrton, Lamb, Smith and Woods, read at the Edinburgh meeting of the Institution of Electrical Engineers, contains much valuable information. There is little in the paper, however, which has not been said before, but it must be conceded that the authors have treated several important points in a most exhaustive manner, and they have furnished experimental proofs on certain phenomena concerning which much doubt has hitherto existed. We must congratulate Prof. Ayrton and his assistants upon the thorough manner in which the task has been performed.

**The Central London Railway Bill.**—The Committee of the House of Lords has decided that the preamble of this Bill "is not proved."

**Wimbledon Lighting.**—It appears that the Wimbledon ratepayers do not take kindly to a circular and accompanying form which Mr. Arthur Holland, chairman of the electric lighting committee, is sending to probable users. A letter in the *Wallington Herald*, of the 12th inst., from Mr. A. Ward, throws much light upon the matter.

**The Old and the New.**—The Old Hall, which now forms a portion of the works of Messrs. Clarke, Chapman & Co., of Newcastle, is the house described by Charlotte Brontë in her famous novel, "Jane Eyre." The place is now virtually the firm's lamp factory, and in the entrance there is fixed and in use what is said to be the largest incandescent lamp in existence.

**Fire Office Rules.**—Mr. John B. Verity writes as follows:—"I venture to trespass on your valuable space in reference to a matter which is engaging a considerable amount of attention amongst electrical contractors at the present time, viz., Fire Office Rules. Formerly most contractors carried out their work as nearly as possible in accordance with the Phoenix Rules, but now every fire office has a special set of rules for electric lighting on its own account. This was, of course, to be expected, as competition among insurance offices is as keen as in any other business. What is the electrical contractor to do? In an important installation the building and contents are often insured in three or four leading offices, all of whom ask if the work has been carried out in accordance with their particular rules; and how can this possibly be done when the rules vary in important respects? It seems to me that the sole remedy is for the electrical contractor to work carefully in accordance with the rules laid down by the Institution of Electrical Engineers. If these rules are considered insufficient in any particular respects, contractors will soon hear of it, and where there is any consensus of opinion, a report should be made to the Institution, and a periodical revision of the rules undertaken by a committee. This, I believe, would do away with the present hopeless condition of affairs, when a surveyor from one leading office expresses great satisfaction with work one day, and the next day a surveyor from another equally important office swoops down and harasses the contractor by demanding alterations which can best be described by F.A.D. in capitals."

**Edinburgh Tramways.**—The question as to the future management of these tramways is beginning to arouse public interest. We may yet possibly see electric traction advocated.

**Connoisseurs from Bristol.**—The Bristol Electric Light Committee has been prowling about in the small hours of the morning, under the guidance of Mr. Preece. Several stations, including Brompton, Sardinia Street, Manchester Square, and Deptford were visited, and Mr. Preece's house was eventually invaded, the committee leaving town with the impression that electric lighting is, at the best, 25 per cent dearer than gas.

**Lighting Newspaper Offices.**—The offices of the *Sportsman*, in all departments, have been fitted with the electric light, in a manner most satisfactory to the proprietors of that journal, by Messrs. Arthur B. Gill and Co.

**A New Insulator.**—The Kinetic Engineering Company sends us the following:—"With reference to the paragraph in your last issue upon what is termed a new type of Berthoud-Borel cable, kindly permit me to say that not only has no such type of cable ever been manufactured by the Berthoud-Borel factory, but that no one connected therewith would ever dream of using such substances as celluloid or tarred hemp for the purpose of cable insulation."

**The Bermuda Cable.**—A New York telegram of last Friday states that communication by submarine cable between the Bermudas and Nova Scotia has been satisfactorily established. The first cablegrams were interchanged between Halifax and the Bermuda station the previous day.

**The Halifax and Bermudas Cable Company.**—The following is a copy of a telegram received by the chairman from the Governor of Bermuda:—"The Chairman of the Halifax and Bermudas Cable Company, London—Many thanks for your message. I warmly congratulate the company on the successful laying of their cable, and sincerely wish them every prosperity."—NEWDEGATE, Governor, Bermuda.

**Telephonic Communication between London and Provinces.**—Last Friday afternoon a wire to London, which was completed late the previous night, was tested at the offices of the National Telephone Company, Faulkner Street, Manchester. Alderman Thompson, who was attending a meeting of the directors of the company at the Cannon Street Hotel, in London, and other gentlemen held conversations with representatives of the Press and others in Manchester, and not only were the words uttered heard quite clearly, but the tones of each voice were recognisable. The new wire, we understand, extends from Sheffield to London, and terminates at the office of the company, Oxford Court, Cannon Street. There is already existing a wire from Sheffield to Manchester, and the two wires were placed in circuit. The gentlemen at the offices of the company in Faulkner Street, Manchester, were thus enabled, with the most perfect ease, to speak to officers of the company in London. Colonel R. R. Jackson, one of the vice-presidents of the company, was one of the gentlemen in London who conversed with representatives of the Press in Manchester. London to Manchester is 221 miles; to Liverpool *via* Manchester, 266 miles; to Sheffield, 195 miles; to Bradford, 252 miles; to York, 275 miles; and to Leeds, 252 miles. It is expected that in the course of a fortnight the London wire will be available for the use of the members of the Exchange in Manchester. Telephonic communication between London and Liverpool was also established last week. Messages were first exchanged between the Mayor of Liverpool and London, and during the afternoon several commercial messages were transmitted. The opinion of those who tested the telephone was that, though 200 miles separate, London and Liverpool messages will be as distinctly heard as if they were transmitted between the local centres.

**Fatal Accident at Blackpool.**—A little boy was last week knocked down by an electric tramcar while crossing the promenade near the Foxhall Hotel, Blackpool, and received such injuries that death resulted almost immediately. The driver of the tramcar was not to blame. The roadway is very narrow at that point, and the little fellow was in front of the car before it could be stopped.

**Telegram Paper.**—A firm of London estate agents bitterly complains of the flimsy pink paper supplied recently for telegrams. For several cogent reasons a change for the better is suggested, in which we entirely concur.

**The Telephone in Italy.**—Telephonic communication is to be established between Rome and Naples, Florence, Genoa, Turin, Milan, Venice, Spezzia, as well as between Turin and Milan, Milan and Venice, Genoa and Turin, Genoa and Florence, Naples and Palermo, and Messina and Palermo.

**Earthquake Shocks and Telegraphic Cables.**—The Eastern Extension Company has had to notify the interruptions of telegraphic communication with Australia by the sudden and simultaneous breakage, on the morning of the 11th, of their three cables between Java and Australia, presumably by earthquake, as shortly before the interruption a shock, said to be the sharpest felt for many years in the neighbourhood, passed over Bangoewangie, at the eastern end of Java, close to which all three breakages occurred. Restoration of communication was expected in about a week's time.

**The Electric Light at Woking.**—The laying of mains for the supply of electric current for illuminating purposes is now proceeding, the mains having been laid underground as far as the railway arch on Goldsworth Road. Everything is expected to be in readiness by the 1st October, and experimental lighting is to take place before that date. A meeting of ratepayers of the parish is to be convened at an early date to take into consideration the desirability of publicly lighting Woking Station district.

**Mahla's Carbons.**—Messrs. Cathcart and Peto have been appointed sole agents in the United Kingdom for the sale of Mahla's electric light carbons. In addition to excellence of quality, unusual whiteness of light and great efficiency is specially claimed for these carbons.

**The Whitehall Club.**—A very good and representative meeting of the electrical members of the Whitehall Club met at dinner on Thursday evening, last week, Dr. Hopkinson presiding. The general feeling of the gentlemen present, who, with a few guests, numbered about 30, was distinctly against anything approaching cliquism, and we imagine that those who have joined the club will simply act their parts as ordinary members without any reference to representing an electrical section of the engineering profession. Messrs. Albright, Sellon and Killingworth Hedges may be congratulated on having secured the subscriptions of a larger number of gentlemen than was actually requisite to meet the concession of the committee, and to participate in the privileges of becoming members of the Whitehall Club.

**Kilmarnock Chemical and Electric Works.**—Messrs. J. and J. Blair intimate that they have added to their business a department of electrical and mechanical engineering, which will be under the immediate superintendence of Mr. James Campbell, late of Anderson, Campbell & Munro, Limited, Hyde Park Electric Works, Glasgow.

**The Compound Winding Case—Judgment Sustained.**—The first judgment in the compound winding suit between Messrs. King, Brown & Co., of Edinburgh, and the Anglo-American Brush Corporation, has been sustained in the appeal case. We shall give the complete text of the decision in our next; but append hereto the precise words of the Judge:—"I am of opinion that the interlocutor of the Lord Ordinary should be adhered to, and decree of reduction of patent pronounced." (The Lord President.) That is the opinion of the Court. On the motion of Mr. Daniell, counsel for Messrs. King, Brown and Company, the Brush Corporation was found liable in expenses.

**The Electric Light at Weybridge.**—At last week's meeting of the Chertsey Rural Sanitary Authority, notice was received from the Laing, Wharton and Down Electrical Construction Syndicate, Limited, that they intend to apply to the Board of Trade for a provisional order for the lighting of Weybridge under the Electric Lighting Acts. The clerk was directed to give special notice that the subject would be considered at the next meeting of the Authority, on August 19th.

**Incandescence Lamps.**—The Brush Electrical Engineering Company, Limited, has acquired the Edison lamp patents for Australasia, India, the Cape of Good Hope, and Natal, and notifies that it is an infringement of the rights now secured by assignment to that company to import, sell, manufacture, or use any incandescence electric lamps in those colonies except under licence from the company. While the Brush Electrical Engineering Company is resolved to assert and to maintain its rights, it will supply incandescence lamps at prices not higher than those which now generally prevail in the colonies.

**Fast Telegraphy.**—We print elsewhere a brief description of the steno-telegraph, a system devised by M. Cassagnes for dealing quickly with a large quantity of telegraph work. In a report by a M. Despeissis on the system, it is stated that steno-telegraphy gives one of the most practical solutions to the problem which has to be faced to-day more than ever, by all telegraphic administrations, viz., the clearing up of their wires. It would seem that the writer is ignorant, not perhaps of the Wheatstone automatic system, but of the capabilities of that system as worked in this country, for satisfactory as the steno system is stated to be, it is certainly quite equalled by the Wheatstone when properly manipulated.

**An Electrical Effect.**—A correspondent, writing to *Nature*, draws attention to a simple experiment which is an interesting variation on the ordinary mode of performing the experiment of putting pieces of zinc and silver in the mouth and touching them, to obtain the acid taste which accompanies the completion of the electric circuit. If the piece of zinc be placed under the tongue, and a florin vertically between the upper lip and the top row of teeth, and the two metals be brought in contact, a faint flash is seen in both eyes when the eyes are open. If the eyes are shut the sensation of light is not felt, so that the effect is probably due to a muscular twitching. It is necessary to use a large silver coin, and not a shilling, and to push it well home behind the upper lip. We are under the impression that this effect is mentioned by Tyndall in his "Electricity," and that the effect is stated to be due to the electric action on the optic nerve.

**The Villard Syndicate.**—A Milwaukee despatch says:—"The three principal street railways of Milwaukee are to be consolidated, under control of the Villard Electric Syndicate. Bonds covering all three properties, the Becker line, the Milwaukee, and the Cream City, are to be issued in place of those now outstanding. About \$2,000,000 new stock and bonds are to be issued. Villard people acquire 50 miles of double track by equipping electrically and taking securities in return." According to another:—"A deal involving upward of \$5,000,000 and including a transfer of a controlling interest in the Badger Electric Light Company, the Edison Light Company, and the Cream City and Milwaukee Street Car Companies, is said in the American papers to have practically been consummated. The purchaser is the so-called Villard syndicate, including Henry Villard and Ryan, the Pittsburg capitalist. But Milwaukee capitalists will still retain an interest in each of the corporations, although there is a complete change of owners in the Badger Electric Light plant. The purchasers outside of the Villard syndicate are the same Milwaukee men who are interested in the Edison Electric Light plant now being built."

**Private Central Electric Lighting Stations.**—It is perhaps a little surprising that so little has been done in the way of private central electric lighting stations; the cause of this has no doubt been due to the very indefinite information which is to be obtained with reference to the economy of the electric lighting system; this, of course, makes householders hesitate before they commit themselves to a plan which may prove unexpectedly expensive, and, they also probably think, troublesome. Far and wide as the electric light is spreading, its advantages are still very far from being understood, and it still requires to be forced into notice. In one or two cases private central stations have been successfully started, and notably at Kirkton Hill, Dumbarton, where Mr. Denny, whose own residence has been lighted for some years by a separate plant, has induced a number of householders to have their houses electrically lighted. Some precise facts as to expense with reference to this and similar plants would be highly useful.

**Deaths from Electric Currents.**—A correspondence between the Foreign Office and the Board of Trade, with reference to deaths from electric currents in the United States, has just been issued as a Parliamentary paper. It appears that the United States Census Office is not at present in possession of the *data* necessary to enable it to furnish the information desired, but the New York municipal authorities state that from January 1st, 1887, to May 15th, 1890, there were 16 deaths from electricity in that city. The Foreign Office and the Board of Trade might have consulted the ELECTRICAL REVIEW with advantage.

**The French Telephones and the State.**—The taking over of the French telephones by the State is leading to heavy outlay, and consequent discussion in the Chambers. Two supplementary credits are now asked for, one for 3,500,000 francs, and another of 1,629,622 francs, by the Ministry of Commerce, in order "to face the expenses of putting in order and extending the telephone lines."

**The Board of Trade Regulations.**—The electric lighting companies, says the *Financial Times* of Tuesday, have still a good deal to contend with at the hands of the Board of Trade. The report of Crompton and Company, Limited, thriving purveyors of electric light, mentions that a contract to light the town of Chelmsford has not been profitable, having "cost more than the original estimate, largely in consequence of unexpected and difficult requirements of the Board of Trade." "It is to be hoped that in the interests of science, of the great sum of capital invested in electric lighting companies, and of the public generally, this Chelmsford incident may be explained and thrashed out at the Crompton meeting next Monday." Perhaps our article on "State Control" may be the means of giving a helping hand to this end.

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## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

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**Dermatine Company, Limited.**—The statutory return of this company, made up to the 8th August, 1889, was filed on the 27th ult. The nominal capital is £550,000 in £5 shares. 6,152 shares are taken up, and 7s. 6d. per share has been called thereon, £26,760 2s. 6d. is considered as paid upon 6,152 shares. The calls paid amount to £2,152 2s. 6d., and unpaid to £154 17s. 6d.

**Mutual Telephone Company, Limited.**—The statutory return of this company, made up to the 17th ult., was filed on the 8th inst. The nominal capital is £45,000 in £10 shares, 12 shares have been taken up, and £1 per share has been called and paid thereon. Registered office, 10, Tokenhouse Yard.

**Trent Gas Engine Company, Limited** (Gas Engineers and Electricians).—The statutory return of this company, made up to the 24th ult., was filed on the 28th ult. The nominal capital is £15,000, divided into 750 preference and 750 ordinary shares of £10 each. The shares taken up are 555 preference and 750 ordinary, 300 of the former and 750 of the latter being considered as paid up. Upon 255 preference shares, £7 10s. per share has been called, the calls paid amounting to £1,912 10s. Registered office, 38, Duke Street, New Basford, Nottingham.

**Archer Pipe Company, Limited** (Pipes and tubes for electric light, telephone, and other wires, &c.).—The statutory return of this company was filed on the 5th ult. The nominal capital is £10,000 in £1 shares. 8,672 shares are taken up, and of these 5,000 are considered fully paid. Upon 3,672 shares, the full amount has been called, the calls paid amounting to £3,467, and unpaid to £205.

### LEGAL.

**In re Northern Electric Wire and Cable Company, Limited.**—Chancery Division (before Mr. Justice Kay). This was a motion on behalf of Mr. Edward W. Hall, asking that the register of the company might be rectified by removing his name from the list of shareholders in respect of 160 £5 shares, and that his deposit money might be returned. Mr. Justice Kay said the facts were these:—On June 25th, 1889, the company was incorporated. Under the articles the subscribers to the memorandum were to be the temporary directors, until directors had been regularly appointed by the subscribers, or a majority of them. At 10.30 a.m. on June 25th, a meeting of the subscribers was held, at which four were present. A resolution was passed appointing directors, and also one allotting shares to different persons, amongst others, 160 shares to Mr. Hall. It was not until July 3rd that Mr. Hall applied for shares. On the 29th of July, another meeting was held, and the minutes of the previous meeting were passed. On the 14th of August, Hall told the secretary verbally that he would withdraw from the company. On the 23rd of August the secretary wrote a new letter of allotment. Upon this, Mr. Hall applied for a return of his deposit, but the directors in December forfeited his shares. Mr. Hall then brought this motion. In his Lordship's opinion there had been no allotment at all. There had been no application followed by an allotment, and a communication of that allotment to Mr. Hall; there had only been an allotment before application. The proceedings were most irregular, and the motion must be allowed, with costs.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Eastern Telegraph Company.

SIR JOHN PENDER, K.C.M.G., presided at the thirty-sixth half-yearly meeting of the shareholders, held at Winchester House on Thursday last, at 1 o'clock, when the following report, with the accounts for the half-year, was presented:—

The revenue for the period amounted to £424,023 14s. 3d., from which are deducted £98,477 16s. 3d. for the ordinary expenses and £47,520 2s. 11d. for expenditure relating to repairs, renewals of cables, &c., during the half-year. After providing £2,943 10s. 7d. for income tax, there remains a balance of £275,082 4s. 6d., to which is added £61,151 1s. 5d. brought from the preceding half-year, making a total available balance of £336,233 5s. 11d.

From this amount there have been paid:—Interest on debentures and debenture stock, £28,274 13s. 1d.; dividend on preference shares, £20,474 3d. 3d.; and an interim dividend of 1½ per cent. on the ordinary shares, £50,000; leaving a balance of £237,484 9s. 7d., from which £125,000 has been carried to general reserve.

The directors now recommend the declaration of a final dividend for the year ended March 31st, 1890, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000 both payable on the 18th inst., free of income tax, and making, with the three previous payments on account, a total distribution of 13s. per share or 6½ per cent. for the year on the ordinary shares. The balance of £2,484 9s. 7d. shown at the foot of the revenue account is proposed to be carried forward to the next half-year.

The revenue includes £74,337 8s. dividend and bonus for the half-year upon the company's investments in the Eastern and South African, the Black Sea, the Direct Spanish and the African Direct Telegraph Companies.

The convention referred to at the last general meeting between the French Government and this company, for the renewal of the agreement for the direct line through France, and the landing and working of submarine cables at the company's station at Marseilles, has since been ratified, and the agreement has been renewed between H.M. Postmaster-General for a special wire by land line and cable connecting this line with London.

A convention has been entered into with the Italian Government for the prolongation for 20 years of the existing concessions, for the working and maintenance of submarine telegraph cables between Italy, Malta, Corfu and Egypt.

The directors have concluded an agreement with the Turkish Government for the laying of a short section of cable between the island of Perim and Sheikh Seyd, which will bring to this company's system the traffic from Hodeida Mocha, and other points on the coast of Arabia now being connected by the Turkish Government with their system of land lines to Jeddah.

The International Telegraph Conference has been held in Paris, at which the chairman, managing director, and other representatives of the company attended. The interests of the company were carefully watched, and the result has, been on the whole not unsatisfactory.

Sundry reductions in the Continental tariffs were made, to come into operation in July, 1891, which will affect the company's revenue to a moderate extent, but the directors hope that the increase of traffic will eventually recoup the loss.

Negotiations of an important character are being carried on between the Eastern Extension Company and the Australasian Colonies, with a view to effecting a large reduction in the tariff to Australasia. This company is interested in these negotiations in so far as it will take a part of the risk, trusting that the reduction of tariff will tend to a large increase of traffic, and it is believed that these negotiations will speedily be brought to a satisfactory conclusion.

The several sections of the company's cables are in good working order, with the exception of the original Red Sea cable, which connects Suakim with Suez and the Island of Perim. The frequent interruptions of this cable taken in connection with the prospect of increased traffic to Australia necessitates the laying of an additional cable in the Red Sea, from Suez to Aden, which the directors expect to have completed and in working order before the end of this year. The cost of this will be taken mainly from the reserve fund.

The Chairman, after explaining some items of the account, said:—On the last occasion he referred to the West Coast system as being fully completed, and that important results might be expected from it. He was now glad to confirm that opinion. One of their sections, the African Direct, was now paying 4 per cent., and he hoped in another year would see an increase upon that. The West African Company was paying a 5 per cent. dividend, and, if the state of things which had existed in Africa continued, they might also expect an increase in that quarter. Altogether they were in a position to meet all requirements which might arise in the development of the "Dark Continent." The company was prepared to do its part in connecting that new world with the old. The trouble which the company had recently experienced in Egypt had given place to a better state of things there, very much to the company's benefit. Its relations with Egypt were in fact most satisfactory. As regards the Telegraphic Conference, its attitude had been on the whole very fair to the cable companies, and this company's relations with European governments had never stood higher. It had had to submit to certain reductions in the interest of Spain, Portugal and Gibraltar, but he anticipated that these reductions would be compensated for by increased business. The company's relations with India were very materially improved at the conference. He further said that he had received a letter from a prominent shareholder, who, after complimenting the management generally, said that, looking to the large sum carried forward, a larger bonus ought to have been declared. He, the chairman, observed, with regard to that, that the company was party to an arrangement with the Eastern Extension Company, whereby the tariff with the Australasian companies was to be reduced from 9s. 4d. to 4s. a word. They had, however, the guarantee of the Governments of those colonies that the companies should not receive less money than they received in 1890. These reductions in tariff must necessarily lead to a very great extension of the system generally. The company's Red Sea cables had been in operation for nearly 20 years, and the directors would not do their duty to the company or the public if they neglected to prepare at once for this increase of traffic. They had, therefore, decided to lay another cable from Suez to Aden, which must cost at least £250,000. With a view to maintaining the respectable dividends which the company now paid, the directors thought it better to pay for that cable at once, and he thought their policy was better conducive to the value of the shareholders' property than by adding to the capital now and eventually reducing the dividends. He moved the adoption of the report and accounts, and to declare a dividend on the preference shares to 30th June, 1890, at the rate of 6 per cent. per annum (less income tax), and a further dividend of 2s. 6d. per share, with a bonus of 3s. per share (free of income tax), on the company's ordinary shares, making, with the previous payments on account, a total of 6½ per cent. on those shares for the year ending March 31st, 1890.

The Marquis of Tweeddale seconded the motion.

Mr. Parsons, a shareholder, assailed the policy of the board, and said that had the company been directed by a body of practical

men, the dividends would have been very much larger. His opinions, however, were apparently not shared by the meeting.

The Chairman thought the meeting would share his contempt for the very remarkable jumble of ideas and ancient history they had just heard, coming, as it did, from one who should know better, he having been some fifteen years ago in the company's service. He, the chairman, had never listened to a greater display of vindictiveness with so little reason.

Mr. Parsons, on rising to make some further observations, was peremptorily informed that he could not be heard.

Mr. J. Gibb then moved a resolution, in which the shareholders expressed their sincere sympathy with Sir John Pender and his family in their present affliction, and which was carried unanimously.

Another Shareholder moved an expression of the obligation which the shareholders felt themselves to be under to Sir John Pender, Sir James Anderson, and other members of the board for their efforts in connection with the Telegraphic Conference, and, with a vote of thanks to the board for its conduct of the company's business generally, the meeting came to an end.

### The Elmore Wire Manufacturing Company, Limited.

MR. GEORGE SMITH, chairman of the Kent Waterworks Company, presided, in the absence of Sir John Morris, at the first general meeting of the company, held at the Cannon Street Hotel on the 14th inst. He explained that it was a formal statutory meeting without report and accounts. But as the shareholders might desire to know what the directors had been doing in the four months of the company's existence, he went on to say—First, as to the subscribed capital: Notwithstanding the adverse state of the financial world at the time of the launching of the company, about 500 applicants had subscribed for shares, and an ample allotment had been made to carry on the company's business. Secondly, as to the company's relations with the Stock Exchange: Application had been made for a quotation and a settlement, and, upon the shareholders agreeing to the proposed alteration in the articles which the Stock Exchange required, the company would doubtless have its application granted. A special meeting would be held for that purpose. Thirdly, as to the land acquired: 12 acres of freehold land had been secured adjacent to the parent company's works at Haigh Park, Leeds, and manufacturing buildings had been erected there under the responsible supervision and control of the company's managers. Fourthly, as to plant: Orders had been given for plant, and would be followed up judiciously until the factories are completed and set to work, which, it was anticipated, would be before the close of the year. The directors' arrangements, with regard to the company's works, had been influenced by the consideration of the many advantages of having them contiguous to those of the parent company, whereby the company would be in a position to share with the parent company the services of the Messrs. Elmore, and so economise an important item of its working expenses, whilst it would secure the presence of Messrs. Elmore always at hand. Fifthly, as to the company's policy: The policy which the directors had elected to follow had been to work with, rather than against, the wire manufacturing trade, and they were happy to be able to say that a very substantial group of Birmingham wire-drawers had offered to take the whole of the company's output of spirals for 1891, with prospective arrangements for continuing the agreement at a price which would yield substantial results to the company. The advantages of such an arrangement were many and obvious. First, the company secured an established trade for all it could make without having to create a trade; secondly, the company enlisted the interested co-operation of some of the most important manufacturers of wire in the company, instead of having them for rivals; thirdly, it avoided bad debts, the firms in question being of the highest standing; and fourthly, the company was released from capital expenditure for wire drawing, and thereby enabled to lay down more deposit plant, and to simplify and increase its business. The terms had been approved, and the agreements would shortly be executed and exchanged by the parties. The directors therefore felt they might congratulate the shareholders of the company upon the prospects before them. Those of them who might wish to see specimens of the manufactures of this depositing process would find them exhibited at 56, Queen Victoria Street, and would do well to inspect them.

An extraordinary meeting was held immediately after the close of the above general meeting, when the following resolution was proposed by Mr. Smith, chairman, and seconded by Mr. Carson:—

"That the following clause be substituted for Clause 80 of this company's articles of association:—

"The company may make contracts with any of the directors upon such terms as the directors shall think fit, and a director shall not by reason of the fiduciary relation subsisting between him and the company be accountable for any profits made by him in respect of any such contract, nor, subject to the following proviso, in respect of any other contract made with the company in the profits of which he participates, or in which he is otherwise interested, provided that the fact of his being so interested therein, and the nature of his interest, be fully and fairly disclosed by him at the meeting of the directors at which the contract is determined on, if his interest then exists, or in any other case at the first meeting of directors after the acquisition of his interest; but in the case of contracts with companies or firms of

which any director of this company is a member, it shall not be necessary to disclose more than the fact of such membership, provided always that in no case shall such director so interested vote, or, if he does vote, his vote shall not be counted."

The Chairman explained that the resolution will be submitted for confirmation as a special resolution at a second extraordinary general meeting, of which due notice will be given.

The Company's Solicitor explained that the proposed alteration of the articles of association is necessary in order to comply with the requirements of the Stock Exchange Committee, before that body will give this company a special settlement and official quotation of its shares.

The resolution was agreed to unanimously, and the proceedings terminated.

### National Telephone Company, Limited.

THE tenth ordinary general meeting of the shareholders was held at the City Terminus Hotel, Cannon Street, E.C., on Friday, the 11th inst., at 12 o'clock, to receive and adopt the report of the directors and the accounts for the year ending 30th April, 1890 (printed in our last issue).

The Chairman, Mr. F. R. Leyland, said that the whole of the amalgamation expenses, by which he meant the Government tax on the increased capital, and the tax on the transfer from the United, and Lancashire and Cheshire Companies, had been included in the year's accounts. The directors had acted on the principle that everything that could be possibly included in the expenses of the year should be so included and paid out of the year's earnings; and, in distinguishing between capital and revenue expenditure, the directors had, in the absence of any doubt, thought it desirable to err on the side of leaving the capital as little augmented as possible. Perhaps the most important consideration was contained in the recommendation made in concluding lines of paragraph I. of the report. That recommendation was made very much upon the same lines and policy as had been pursued in making up the accounts. The directors thought it desirable, now they had a year at least before them, to strengthen their position by adding to the reserves and declaring only a moderate dividend. Six per cent. was not an unsatisfactory dividend. They had to face the fact that competition might arise. They knew that one competing company had already been formed in Manchester. Fortunately it was not a very strong one, and it had a good deal to learn, as they would find. The patent which would be the first to expire was the Bell receiver, which would expire in December. He had been told that it would be utterly impossible for the competing company to carry on its business as it said at the expiration of that time. The patent might be used for a small exchange with advantage, but would be impossible in a large exchange. Their competitor would have to wait until the second patent, viz., the transmitter, expired in July, 1891. But even then there would be other patents which did not expire until 1893, and were all of material advantage to a good service. Letters had appeared from time to time in the Press, from the Mutual Company and others not connected with it, but apparently taking a very great interest in telephone matters; and, more especially, there was the speech of the Duke of Marlborough in the House of Lords; the statements contained in them all seemed to be founded on the assertion that the telephone service abroad could be done for very little—something like £4 6s. 8d. per subscriber—the charge made in Norway, in Sweden. How could they possibly compare Stockholm and Christiania with London, Manchester, Liverpool, Glasgow, &c.? Then, a large item in the construction account was for poles for carrying the wires. In Norway and Sweden they had these poles on the spot. There was also the relative cost of labour to be considered. Then companies in Norway and Sweden were not subjected to a tax of 10 per cent. on their gross income. Foreign companies were not required to pay for way leaves, whereas the amount which the company had to pay for way leaves was £25,000 per annum. The Duke of Marlborough said that in Paris there were three or four times as many subscribers to telephones as in London. The fact was, there were 7,800 subscribers in Paris, and 5,800 in London. That was a sample of the reckless statements that were made outside. The Duke also said that the charge for the telephone in London was £20 a-year, whereas the average charge in all continental capitals was only £6. Let them take Paris. The companies there used to charge £24. The Government took over the telephones, and, having no desire to make a profit, reduced the charge to £16. They must go a long way among European capitals to get anything like an average of £6, when they commenced at £16. In the French provinces subscribers had to buy their own apparatus and pay the cost of the wire as well. In Berlin, and throughout Germany, an average charge was made all round of £7 10s.; but then there was no 10 per cent. payable to the Government, no cost of way leaves. The Government might fix the standard on your house-top or in front of your door—whether you liked it or not. In Madrid the charge was £12; St. Petersburg, £23 2s. 6d.; Sweden and Norway, £4 8s. 10d. and £4 8s. 1d.; but in these countries they only allowed you a certain number of conversations in the year, and charged you an extra amount for every conversation above that number. In New York they charged £30 to £36; Boston, £19 to £24; Chicago, £25; Pittsburg, £16 16s. to £20; Washington, £12, £16 and £20, according to distance; New Orleans, £19 15s.; Philadelphia, £24. As regards dealing with competition there would be no relinquishment of the company's position, and all measures necessary to strengthen it, and to keep the field, for it would be

taken. Economy of working and efficiency of service were most important considerations. Efficiency of service had been the first to engage the directors' attention. They had found, in London especially, that a great many of the switchboards were of an antiquated pattern. These had all been replaced with the exception of two. Then they had had to deal with the junction wires. One of the greatest defects of the London system had been the multiplicity of these exchanges. These had been considerably reduced, in the City especially, and the reduction would be continued until, if possible, the whole was got into one or two exchanges. The junction wires had been improved and looped to the extent of 350 miles, and there were 1,200 still to be done. Some 1,700 of the instruments had been fitted with magnetos, leaving about 350 to be done, and various other improvements had been made. To have done more than had been done would have involved a serious stoppage of the service. As regards the trunk line to the North he was very pleased to be able to tell them that they had at last got into communication with Manchester, Liverpool and Birmingham. The trunk lines would be one of their great standbys in competition. They were now pretty well all over the country. They had all been profitable, *i.e.*, they returned a fair interest for money expended. They had now a larger business being carried on at practically the price for which they had formerly carried on a much less important one, and he had no doubt that next year they would have a better report—certainly one as good. They must, however, take the labour difficulty into account. Everyone was asking for an increase in wages. The taking over of the Northern District Telephone, completed about a month ago, was, he thought, a wise thing for themselves, and he was sure a necessary thing for the Northern Company. It saved considerably in the working expenses, and secured a promptness of decision on the part of the board which could not be when they had three separate boards. The policy of the amalgamated companies was to include the South of England and the Western Counties, the only two counties now outside the amalgamation. That was, however, a question of price. The number of proxies sent in, *viz.*, 81,788 shares out of 468,984, was a substantial expression of opinion in favour of the board. He had recently received a letter from a very important shareholder, and one who had considerable experience in financial matters, on the question of dealing with the reserve fund. The writer appeared to be in favour of investing it in marketable securities. If so, they ought also to invest in securities in which there was not a large fluctuation in price. But in that case, there was little chance of more than a very low interest. Where was the policy of investing money which would not give more than 3 per cent. and borrowing money for the purpose of extending capital, paying 4 per cent. for it at the least. At present the reserve was being largely employed in buying up the Northern District. The old shareholders were given the choice of payment in the company's ordinary shares, or in sovereigns. They chose the latter, whereby the company made a better bargain. The policy of the board would be a big reserve and a moderate dividend. He moved that a dividend at the rate of 6 per cent. per annum (less income tax) on the first and second preference shares, and on the fully paid ordinary shares (excluding the 52,109 new ordinary) be paid for the half-year ending 30th April last, making, with the interim dividend already paid, a total dividend of 6 per cent. for the year.

Mr. J. S. Forbes seconded the motion, which was carried unanimously. Messrs. Welton, Jones & Co. were reappointed auditors, and with a vote of thanks to the board, the meeting came to an end.

### United River Plate Telephone Company, Limited.

The report of the directors to be presented to the shareholders at the fourth ordinary general meeting to be held at Winchester House, 50, Old Broad Street, E.C., on Tuesday, the 22nd July, 1890, at 12 o'clock noon, states the result of the company's operations during the year ending 31st March last, after paying all working expenses abroad, debenture interest, London and other charges, is a profit of £34,198 6s. 5d., from which has to be deducted the sum of £22,334 17s. 1d. for loss on exchange, leaving a net profit of £11,863 9s. 4d., increased by the balance of £1,210 7s. 2d. brought forward from the previous year, to £13,073 16s. 6d. Out of this, an interim dividend of 2 per cent., or £5,800, was paid in January last; and the directors recommend that out of the remaining balance of £7,273 16s. 6d., a further dividend of 1 per cent., or 1s. per share, free of income tax, be now paid, which absorbs £2,900; that £2,000 be placed to the depreciation and renewal fund, thereby increasing it to £9,000; and that the balance of £2,373 16s. 6d. be carried forward to the credit of profit and loss account for the current year. As shown in the balance sheet annexed, the capital expenditure during the year amounted to £12,772 8s., as against £35,070 2s. 11d. in the previous twelve months. The business of the company has largely increased during the past year, the gross receipts having been £108,612 2s. 7d., as compared with £81,866 2s. 4d. in the year before; such a development of business has necessarily increased the working expenses in the River Plate, and the continued depreciation in the currency there has naturally given rise to a necessity for higher wages. In spite of these difficulties, the result of the company's working would have been very satisfactory but for the serious increase (more especially during the second half-year) in the loss on exchange, which amounted to £22,334 17s. 1d., as against £14,689 6s. 8d. in the previous year, the net profits having been thereby so reduced as to make it impossible for the

directors to recommend so high a dividend as last year. But to meet this loss on exchange to some extent, the directors raised the rates of subscription on the 1st January last, and they are glad to say that the change has been carried out successfully. The shareholders will remember that the directors were authorised at an extraordinary general meeting held on the 9th January this year to issue debenture stock and convert the then existing 7 per cent. debentures; and the directors are glad to report that out of £100,000 7 per cent. debentures, £97,000 have been converted into 5 per cent. debenture stock, and that £29,000 of the same stock, offered to the shareholders, was largely over-subscribed. Under the articles of association, the Right Hon. Lord Thurlow and Mr. Frederick Green retire by rotation at this meeting, but, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. & Co., also retire, but offer themselves for re-election.

### Crompton and Company, Limited.

THE second report of the directors, to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon Street, in the City of London, on Monday, the 21st July, 1890, at 2.30 o'clock, p.m., states:—The net profits for the year amount to £10,610 1s. 7d., and after payment of the interim dividend last December, and providing for debenture interest and other payments set out in the accounts, there remains a balance of £6,030 6s., from which the directors propose, after setting aside a sum of £500 as a provision for doubtful debts and contingencies, to declare the usual dividend of 7 per cent. per annum upon the preference shares, and 5 per cent. per annum upon the ordinary shares, carrying the balance forward. The business of the company has greatly increased, necessitating considerable extension of the works, and large additions to plant. The contract for the public lighting of Chelmsford has been carried out, and the result has given great satisfaction in the town. It is hoped that private consumers will now apply for the light in sufficient numbers to make the contract a profitable one. The installation has cost more than the original estimate, largely in consequence of unexpected and difficult requirements of the Board of Trade. Very important contracts have been arranged with several of the electric supply companies in London, the principal feature of which is that this company receives a fixed profit upon the actual cost of the works, and large orders are also in hand for other companies and firms, the prospects of the present year being in consequence very good. It is with the greatest regret that the directors have to record the loss, by death, in October last, of Viscount Torrington, the chairman of the company. In accordance with the articles of association, Sir Charles Grant retires from the Board of directors by rotation, but offers himself for re-election. The auditors, Messrs. J. H. Duncan & Co., also offer themselves for re-election.

### The Direct United States Cable Company, Limited.

—The board has resolved to recommend a final dividend of 3s. 6d. per share, free of income tax, such dividend to be payable on and after the 26th instant, making, with the interim dividends already paid, 3½ per cent. for the year ending 30th June last, carrying forward £968 0s. 3d., after having transferred to the reserve fund account £8,502 14s. 5d., making it up to £250,000. Notice is also given that the transfer books of this company will be closed from the 11th to the 25th July, both days inclusive.

**The Edison and Swan United Electric Light Company, Limited.**—The directors announce a dividend at the rate of 7 per cent. per annum on the "A" shares for the half-year ended the 30th ult. (making 7 per cent. for the year), and a further dividend of 4 per cent. in completion of payment of arrears of cumulative preference dividend for the year ended June, 1884, and a further dividend of 4 per cent. in respect of arrears of cumulative preference dividend for the year ended June, 1885.

**Parker's Electric Wire Corporation, Limited.**—A general meeting of the members of this company will be held in Temple Chambers, Temple Avenue, London, E.C., on the 12th August, at 4 p.m., when an account will be produced of the winding up of the company, and other business transacted.

**MacNabon's Electric Automatic Registering Company, Limited.**—A general meeting of the shareholders will be held at the office of the liquidator, Mr. Wm. G. Jefferys, 53, Coleman Street, London, E.C., on the 18th August next, when the liquidator's accounts will be produced.

**The Globe Telegraph and Trust Company, Limited.**—The directors propose a final dividend of 4s. 3d. per share, making 5 per cent. for the year ending the 18th inst., a balance of £108 being carried forward.

**The Edison Electric Illuminating Company, New York,** has declared a quarterly dividend of 1 per cent., payable August 1st.

### TRAFFIC RECEIPTS

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 14th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,644.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 16).	Closing Quotation. (July 17.)	Business done during week ending July 17, 1890.	
					Highest.	Lowest.
£250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100 xd	97 — 100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51		
2,725,420	Do. do. 6 p. c. Preferred	Stock	85½ — 86½	86 — 87	86½	86
2,725,420	Do. do. Deferred	Stock	14 — 14½	14½ — 14½	14½	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12½ xd	11½ — 12½	11½	11½
99,000	Do. do. 5 p. c. Bonds	100	102 — 104	102 — 104		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107 xd	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 2½	1½ — 2	2½	2½
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 1½	1½ — 1½		
\$7,216,000	Commercial Cable, Capital Stock	\$100	103 — 105	103 — 105	103½	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	5 — 5	5 — 5		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,000	Cuba Telegraph, Limited	10	12½ — 12½	12½ — 13½	12½	
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	17½	
12,931	Direct Spanish Telegraph, Limited (£4 only paid)	5	3½ — 3½	3½ — 3½		
6,090	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	10½
400,900	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½	14 — 14½	14½	14
70,000	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 — 111	108 — 111		
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	107	
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14½ — 14½	13½ — 14½ xd	14½	13½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	101 — 103	101 — 103		
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106 xd	103 — 106	103½	
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106 xd	103 — 106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	100 — 103 xd	100 — 103	101½	
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5½ — 6	5½ — 6½	5½	5½
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 (£3 only paid)	5	2 — 2½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited	10	9 — 9½	9½ — 9½	9½	9
180,042	Do. do. 6 p. c. Preference	10	15½ — 15½	15½ — 15½	15½	15½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½ xd	15½ — 16½ xd		
40,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103 xd	100 — 103	101	
250,000	Do. do. do. (issue of 1883)	100	105 — 108	105 — 108		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	12 — 13	12 — 13		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	19 — 20	18½ — 19½ xd	19½	19½
200,000	Do. do. do. 4½ p. c. Deb., 1896	100	103 — 105	103 — 105		
17,000	Indo-European Telegraph, Limited	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures	100	107 — 110	107 — 110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4½ — 5	4½ — 4½	4½	
386,875	National Telephone, Limited, Nos. 1 to 386,875	5	5½ — 5½	5½ — 5½	5½	5½
49,825	Do. do. New Nos. 386,876 to 436,700	5	5½ — 5½	5½ — 5½	5½	5½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 13	12½ — 12½		
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10½ — 10½	10½ — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¾ — ¾	¾ — ¾		
9,000	Reuter's, Limited	8	7½ — 8½	7½ — 8½	7½	
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	¾ — ...	¾ — ...		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3½	2½ — 3½		
3,351	Submarine Cables Trust	Cert.	112 — 116	112 — 116	114	
78,949	Swan United Electric Light, Limited (£3½ only paid)	5	5 — 5½	5 — 5½	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	43 — 45 xd	44½	44
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102 xd	100 — 102		
55,000	United River Plate Telephone, Limited	5	4½ — 5	4½ — 4½		
146,000	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94 xd	90 — 91		
100,090	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	... — ... xd	... — ...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9½ — 10½	9 — 10 xd		
300,000	Do. do. do. 5 p. c. Debentures	100	99 — 102	99 — 102	99½	
30,000	West Coast of America Telegraph, Limited	10	6½ — 7	6 — 6½		
150,000	Do. do. do. 8 p. c. Debs. repay. 1902	100	108 — 112 xd	106 — 110	108½	107½
64,572	Western and Brazilian Telegraph, Limited	15	9½ — 10½	10 — 10½	10½	10½
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 7	6½	6½
26,986	Do. do. do. 5 p. c. Deferred	7½	3½ — 4	3½ — 4½	4	
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	106 — 109	106 — 109		
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 — 107	104 — 107		
88,321	West India and Panama Telegraph, Limited	10	2½ — 2½	2½ — 2½	2½	2½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11 — 11½	11 — 11½	11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	12½ — 13½	12½ — 13½		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
179,300	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 101	99 — 101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 2	1½ — 1½		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½ — 7½. — Electric Construction Corporation (£10 paid), 8½ — 9. — House-to-House Company (£5 paid), 4½ — 5½. — London Electric Supply Corporation, Ordinary (£5 paid), 1½ — 2½. — Manchester Edison and Swan Company, £9, (£1 paid), 11/- — 12/-. Elmore Wire, ½ dis — par.

BANK RATE OF DISCOUNT.—4 per cent. (26th June, 1890).

ELECTRIC LIGHTING AND COUNTY  
COUNCIL.

## PROVISIONAL ORDERS FOR NEXT SESSION.

At the meeting of the London County Council on Tuesday last at Spring Gardens, under the presidency of Sir John Lubbock, Mr. T. B. Westacott (the chairman of the Highways Committee) presented a report, which stated, for the information of the Council, that the following notices of intended applications next session for provisional orders under the Electric Lighting Acts had been received:—

Undertakers.	Areas of Supply.
St. James and Pall Mall Electric Lighting Company.	Parishes of St. James, Westminster; and St. George, Hanover Square.
Brush Electrical Engineering Company.	Parishes of Fulham, Hammersmith, Islington, Shoreditch, St. Luke, Clerkenwell, Bethnal Green, and Districts of Hackney and St. Saviour.
Laing, Wharton and Down Syndicate.	City of London (east and west districts); Parishes of Shoreditch and Islington; and Districts of Hackney and Whitechapel.
Westminster Electric Supply Corporation.	Parishes of Paddington, Chelsea, St. Marylebone, Kensington, and St. Margaret and St. John, Westminster (part of).
New Cadogan and Belgrave Electric Supply Company.	Parish of St. George, Hanover Square.
Ditto ditto	Parish of Chelsea.
London Electric Supply Corporation.	Area not specified.
Metropolitan Electric Supply Company.	Ditto

## LONDON ELECTRIC SUPPLY CORPORATION.

The same committee reported that they had considered a notice from the London Electric Supply Corporation (with one plan) of intention to lay trunk mains in Stamford Street, York Road, Sutton Street, and Belvedere Road; together with a letter from the company asking that, as it had arranged a new route for its mains, this notice might be taken in substitution for that dated April 18th, 1890, the works referred to in which were approved by the council on May 1st last. "The council will probably not think it desirable to interfere with the discretion of the company with reference to the route to be adopted for its trunk mains; but your committee think that, in order to obviate the necessity of a second interference with the same streets, the company should be required to lay its distributing mains at the same time as the trunk mains. Your committee therefore recommend:—That the sanction of the council be given to the works referred to in the notice (Registered No. 96) of the London Electric Supply Corporation, dated June 19th, 1890, upon the following conditions:—That the distributing mains be laid at the same time as the trunk mains, in order to avoid a second interference with the same streets; that the mains be protected from injury by a sufficient outer covering, to the satisfaction of the council's engineer; and that the company do give three days' notice to him before commencing the work in any of the thoroughfares referred to in the notice."

The same company had also asked for the consent of the council to an alteration of the route of its mains in Cockspur Street, from the south side, as shown upon the plan submitted with the notice dated June 4th, 1890, sanctioned by the council on June 24th last, to the north side of that street. "This alteration, which is shown upon a plan submitted by the company, requires to be made in order to meet the wishes of the Postmaster-General; and your committee, seeing no objection to it, recommend:—That the Council do consent to the alteration of the route of the London Electric Supply Corporation's mains in Cockspur Street (referred to in the notice Registered No. 90), as shown upon the plan submitted by the company."

Both these recommendations of the committee were approved by the council.

## MISCELLANEOUS.

The Highways Committee further reported that they had considered a letter from the Board of Trade, forwarding, for the observations of the council, a copy of an application from Messrs. Woodhouse and Rawson United, Limited, for permission to purchase from the West Middlesex Electric Lighting Company the undertaking authorised by the Fulham District Electric Lighting Order, 1884, which order was revoked by the board in October last. This order did not, of course, contain the provisions conferring powers upon the council, introduced last year for the first time into electric lighting orders relative to the County of London, and the committee did not consider that it would be desirable to revive an order of the old form, unless it could be brought into conformity with those of last year. They therefore recommended, and the council resolved, as follows:—"That the Board of Trade be informed that in the opinion of the council the permission asked for by Messrs. Woodhouse and Rawson United, Limited, should not be granted, unless the provisions of the Fulham District Electric Lighting Order, 1884, be so modified as to make them accord with the orders recently granted by the board."

Mr. JOHN HUTTON, as chairman of the Building Act Committee, submitted their report, which made the following, among other recommendations, which was agreed to:—"That the application of Mr. E. Garcke, on behalf of the Brush Electrical Engineering Company, Limited, for approval of a plan for the construction of an addition to a temporary iron building in Belvedere Road be not granted, as the committee consider it undesirable to sanction the erection of any additional temporary structure at the premises in question."

## BARNSELEY AND ELECTRIC LIGHTING.

MR. J. H. TAYLOR, borough surveyor, has prepared a report on the proposed electric lighting of Barnsley. The report gives the results of the labours of the Park and Lighting Committee of the Barnsley Town Council in the matter, they having had it under consideration for almost a year past. It states that tenders were invited, but the "high charges and excessive terms of purchase asked by the companies" were such that they were compelled to relinquish all ideas of introducing the electric light to Barnsley by the medium of a private company. The committee then invited tenders for the supply and erection of a complete plant for lighting with electricity the streets, roads, and other places within what is called the inner area, and which practically comprises the whole of the business portion of the town, and also for lighting 5,000 10-candle-power lamps, or their equivalent in arc and incandescent lamps, in buildings within the inner area. The corporation in this case is to provide the buildings, the contractor to provide and build the foundations for all engines, dynamos, and boilers, and to lay out the plant in the best manner of extending the same, so that eventually the whole of the borough may be lighted from the central electric lighting station, appliances to be provided for supplying 50 arc lamps of 1,200 candle-power each; 142 incandescent lamps of 32 candle-power each; and 5,000 lamps of 10 candle-power each, or their equivalent in arc and incandescent lamps, and with one engine and boiler, and one each of the arc and incandescent light dynamos to spare. Lamps and posts for 50 arc lamps and 140 incandescent lamps are to be provided of ornamental design in iron; the cables and wires of copper properly insulated and erected overhead. The necessary precautions for the proper carrying out of these tenders are taken. In response to these proposals tenders were obtained from several companies. The Gülcher (New) Electric Light and Power Company, Limited, offer to do the work for £25,500, subject to a reduction of £2,000 if bare copper mains are used. The Electric Construction Corporation, Limited, submits two tenders—one of £22,751, and the other of £21,721. The Manchester Edison-Swan Company, Limited, tender to do the work for £19,200, or for £2,000 less if the cable supports are made partially or entirely of wood. The other tenders are:—Westinghouse Electric Company, Limited, £17,800; Laing, Wharton and Down Construction Syndicate, Limited, £16,975; Brush Electrical Engineering Company, Limited, £13,100; and National Electric Supply Company, Limited, £11,888. On these tenders and the whole scheme proposed for the electric lighting of the borough, Mr. A. Bromley Holmes, electrical engineer, of Liverpool, was consulted, and he recommended the adoption of the "high tension alternating system" as the best and most suitable for a town like Barnsley, and after giving his reasons against the proposals of the other companies, so far as Barnsley is concerned, recommends that of the Westinghouse Electric Company, Limited, £17,800, as the most favourable. In a subsequent report, Mr. Holmes states that he has inspected the Westinghouse installation at Sardinia Street, London, made by the company for the Metropolitan Electric Supply Company, Limited, and finds the arrangement simple and practical, the plant well designed and constructed, and working in a perfectly satisfactory manner. Certain modifications suggested in the original tender have been agreed to by the company, and Mr. Holmes says he can now recommend its acceptance, and adds that in the estimate of capital expenditure it would be well to add £700 for mechanical stokers on the boilers, and for additional transformers, making a total of £18,500. He submits an approximate estimate of such a station for Barnsley, as follows:—Cost of water, oil, waste, &c., £1,450; renewal of carbons and street incandescents, £225; salary of chief engineer and assistant, £350; wages of enginemen, stokers, linemen, and labourers, £936; collector and clerk's assistance, £200; sundry expenses, £200—£3,361. Interest, sinking fund (five per cent. on cost of site and buildings, £4,000), £200; 10 per cent. on cost of plant, &c., including repairs (£18,500), £1,850—£2,050; making a total estimated annual cost of £5,411. Mr. Holmes adds:—"Assuming the 5,000 ten candle-power incandescent lamps to be used on the average 800 hours per annum, each lamp would consume approximately 32 units of electricity, which, if sold at 6d. per unit, would bring in a revenue of £4,000. Deducting this sum received for private lighting from the working costs given above, would leave a balance of £1,411 as against the street lighting. The street arc and incandescent lamps would replace 248 gas lamps, giving a total light of 6,574 candles, costing £800 per annum. The 50 arc and 140 street incandescent lamps would give a total light of 54,480 candles. The cost of extending beyond the inner area would probably be £50 for each arc lamp and £10 for each 32 candle-power incandescent lamp." On these facts and figures the committee recommend that the tender be accepted of the Westinghouse Electric Company.

## REVIEWS.

*Derivation of Practical Units.* By Lieut. F. B. BADT and Prof. H. S. CARHART. Electrician Publishing Company : Chicago, U.S.A.

This small work is mainly a reprint of articles published in the *Western Electrician*. Its title, though it no doubt is, strictly speaking, correct, is, we think, very liable to be misleading, as the book is not a scientific treatise on electrical units, but a series of short illustrated biographies of famous electricians to whom the system of electrical units is practically due and by whose names the units are designated. A final chapter by Prof. Carhart deals briefly with modifications of the practical units.

*Inventions and How to Patent Them. A Practical Guide to Patentees.* By EUSTACE SMITH. Third Edition. Revised. London: Whittaker & Co., Paternoster Square.

This is an exceedingly handy and useful little volume, and should be possessed by all who are interested in the subject. The sections into which the work is divided are as follows:—What is a Patent? What Inventions can be Protected by a Patent? When is a Patent New? When is a Patent Useful? What amount of Invention is Necessary to Support a Patent? Who may apply for a Patent? How to obtain a Patent; Dealings with Patents; Retention of Patents; Information on Practical Points.

*Journal of the Institution of Electrical Engineers.* No. 87. London: E. & F. N. Spon, 125, Strand.

The contents of this number are as follows: "On Signalling across Rivers in India," by W. F. Melhuish; "The Diathermancy of Air in Relation to the Efficiency of Incandescent Lamps," by F. Higgins; "On Lightning Guards for Telegraphic Purposes, and on the Protection of Cables from Lightning," by Oliver J. Lodge; Original communications, Abstracts, &c.

## ALTERNATING CURRENT MOTOR.

THE accompanying cut from an American exchange, illustrates diagrammatically an alternating current motor, recently patented by Elihu Thomson, of Lynn, Mass. Rotation in this motor is due to the reaction between an alternating current field and a locally short-circuited armature. These motors, when running at normal speed, are capable of sustaining speed in synchronism, or nearly in synchronism, with the alternations of the feeding wire, but are incapable of starting.

The invention consists in commencing to run the motor with a different circuit arrangement for its armature from that which it will have under the condition of steady normal working. This primary condition is one adapted to give a torque. When up to speed the motor is run with the armature on continually-closed circuit.

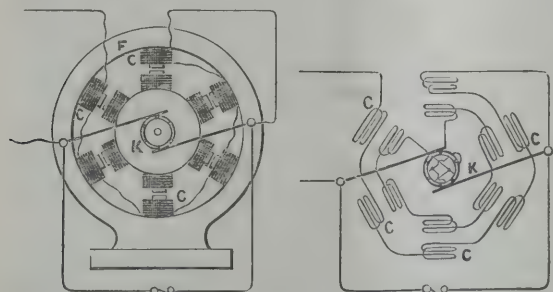


FIG. 1.

FIG. 2.

In the accompanying cuts, fig. 1 is a side elevation of a form of motor to which the invention may be applied. Fig. 2 is a diagram of the circuits and connections of the apparatus. In the figures, F represents a laminated field magnet frame having projections upon which are

wound coils, C, as many as six in number. These projections extend inwardly toward a revolving laminated armature. Upon the shaft of the machine is a commutator, K, consisting of six segments, each alternate segment being connected, so that there are in reality but two divisions of three segments, each fitted together. The armature coils are so connected that if a continuous current were passed through the coils the projections on the armature would assume alternately north and south polarities. The field coils are connected in a like manner. Now if an alternating current be passed through the field coils, C, the motor will not start to rotate whether its armature circuit be practically open, or whether the coils be on closed circuit; but it will continue to rotate in either direction if it is once started, if the armature coils are placed on closed circuit, and the current fed to the coils, C, has sufficient energy. In the motor shown, the alternating current which passes through the field is made at the start to circulate through the armature. In the initial condition of the motor the brushes are set backward or forward into proper position, where the armature will begin to rotate. When a certain speed has been obtained, the motor is made to assume its normal working condition and to continue its rotation without the commutator by short-circuiting the armature by any desired means. These changes of condition may be made by devices manually operated; but the inventor prefers to bring them about automatically by the operation of some device responsive to the change of speed of the armature.

## ACTION OF LIGHTNING UPON THE HUMAN ORGANISM.

ACCORDING to Vienna papers of the 4th inst. Prof. Nothnagel, in his clinical lectures, yesterday exhibited to his hearers a young woman, aged 20, Josepha Schleser, who had been recently struck by lightning in Styria, and had come to Vienna for treatment in Prof. Nothnagel's hospital. The patient suffered from a derangement of the nervous system. To his remarks on this case the lecturer added a discourse on the effects of lightning, substantially as follows: Formerly it was known merely that the burns occasioned by lightning had a zigzag figure, and that the further consequences might be paralysis or death. During the last ten years the lecturer had made comprehensive experiments upon rabbits with the electric spark of a large Leyden jar, and has thrown a new light upon this question. The action of lightning upon the brain, the spinal column and the peripheric nerves is shown by the loss of consciousness, the disturbance of the intellect, and the extended phenomena of lameness, the latter of which have a tendency to disappear. On the other hand, there are intense nervous phenomena which strongly resemble those produced by railway accidents and other concussions, and which dominate the patient for a long time. Disturbances of sight and speech often occur, and may remain for life, or may in part disappear. In other cases there may be observed in the person struck a childish frame of mind which may incline either to reckless merriment or to sadness and melancholy. Experience proves that lightning produces its chief effects only at the points of its entrance and exit. Thus a flash which entered a schoolroom injured only the first and last child on the form, those between escaping unhurt. Prof. Nothnagel pointed out that in the treatment of lameness and other constitutional perturbations due to lightning metallotherapy is most efficient, a large horseshoe magnet being applied alternately to the head, trunk and the limbs. This process led to better results than the electric treatment recently adopted. In case of a quite recent stroke the clothing should be unfastened, the patient laid with the head high, quietness and fresh air should be secured, and if consciousness does not return the head should be exposed to a stream of cold water.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

"The Working Efficiency of Secondary Cells." By W. E. AYRTON; C. G. LAMB, E. W. SMITH and M. W. WOODS, Associates. Read at Edinburgh, Wednesday, July 16th.

I.—PREVIOUS TESTS OF CELLS.

Since 1881, when the formation of Planté storage cells was greatly accelerated by Faure's device of pasting the plates, numerous tests have been made in different parts of the world on the capacity and efficiency of secondary cells. The first tests that were carried out were conducted simultaneously, at the end of 1881, in England by Prof. Perry, with one of the authors of this paper, and in France by a committee consisting of Messieurs Tresca, Potier, Joubert and Allard, working at the Conservatoire des Arts at Metiers, with a staff of assistants.

In the report—communicated to the Physical Society in February, 1882—by the two English experimenters, it was pointed out that the great "resuscitating power" of the cells made it very difficult to say when they were entirely discharged, and therefore, in order to test the efficiency, the cells were first "emptied" of charge by discharging them until the discharge current was very small, and finally leaving them short-circuited for many hours with a short bit of thick wire. Next, a measured amount of energy was put into these "empty" cells, and they were then thoroughly discharged on three successive days, being insulated and allowed to recuperate during the two intervening nights. Although the energy efficiency thus obtained, and which was not less than 82 per cent., probably represented much more than could be obtained in practice at that period, if the discharge were stopped before the E.M.F. fell to so low a value, this efficiency represented something quite definite, since all the energy given out by the cells in the discharge must have been put into them during the measured charge, no demand being made on some inexhausted store of energy previously put into the cells.

The French committee, on the other hand, considered the cells as being discharged when a certain current which was originally produced through a fixed resistance by 30 cells could no longer be kept up, even when the number of cells had been increased to 35. But unless, subsequently to the receipt of the cells from the manufacturers, they had been charged and discharged several times until the same cycles of values of E.M.F. with time were repeated with each charge and discharge, there was no guarantee that in the experimental discharge the cells were not drawing on a store of energy put into them before leaving the manufacturers' premises, and thus giving a higher value than the "working efficiency."

And we are afraid that a very possible neglect of the powerful resuscitating power of accumulators may have vitiated some of

the published results of experiments that have been made on them. This doubt must not be forgotten in considering the accompanying list, which is as complete as we have been able to make it, of all such experiments that have been made up to date. At the middle of 1889, when we had nearly completed our investigation, there appeared two very important contributions to the subject—one on "The Inherent Defects of Secondary Batteries," by Dr. Louis Duncan and H. Wiegand; the other, "Ergebnisse von Versuchen an Akkumulatoren für Stationsbetrieb," by Prof. W. Kohlrausch and C. Heim. These investigations are extremely interesting, as they confirm some of the results which we had also arrived at, and to which reference will be made in this paper; Prof. W. Kohlrausch and C. Heim, for example, laying great stress on the fact that the discharge of an accumulator does not depend merely on the previous charge, but on the previous history of the cell.

At the Central Institution there are three distinct types of E.P.S. cells in daily use. The cells, however, used by us for the investigation were 20 out of a group of 50 of what is known as the 1888 type. This type we selected since it was the latest constructed by the Electrical Power Storage Company. The particular specimens of this 1888 type, which are at the Central Institution, contain each two positive and three negative plates, each plate, exclusive of the lugs, being 9½ by 9½ inches. The glass vessels containing these plates are large enough to each hold 7L plates, but we preferred to use 7L glass boxes to having smaller boxes specially constructed.

The total weight of each of these cells is about 59 lbs. 12 oz., made up as follows:—

	lbs.	oz.
3 negative plates ... ..	about	17 2
2 positive " " " " " "	"	11 8
Ebonite strips ... ..	"	0 8
1 glass vessel ... ..	"	7 8
Dilute sulphuric acid ... ..	"	23 2

and the cells are intended to be used with a maximum current of 9 amperes on charging and 10 on discharging.

The first point to settle with reference to the discharge was whether the resistance in the circuit should be kept constant, or whether as the E.M.F. fell the resistance should be varied in such a way as to keep the current constant. This latter method, although it involved much more labour, was adopted. At first the current was kept constant by varying the resistance by hand as the E.M.F. of the cells altered. But this required the constant presence of one of the observers day and night, partly to vary the resistance from time to time, and partly to start the charging directly the discharging was finished, in order that the cells might never be left discharged. Hence an automatic arrangement, which will be described later on, was subsequently devised, and by means of it the current was maintained more constant than could be achieved by even very careful hand

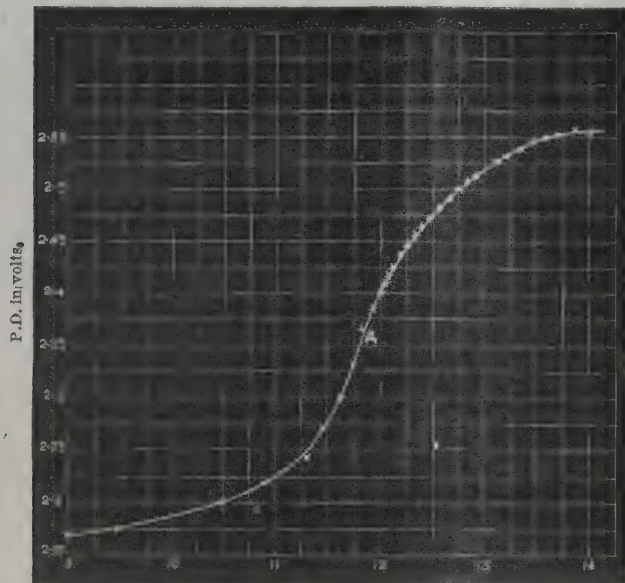
Efficiency Tests of Accumulators.

Date.	Maker of Cell.	Experimenters.	Efficiency.		Remarks.
			Quantity.	Energy.	
1882	Faure ... ..	Ayrton and Perry ...	...	82	Cells short-circuited for some time before being tested. Cells discharged on three successive days, and allowed to recuperate during the two intervening nights.
1882	" ... ..	French Commission ..	92	70	Result of a week's work. Current kept fairly constant during discharge by the addition from time to time of fresh cells.
1883	Schultz ... ..	Hallwachs ... ..	...	6 to 50	Results variable and indefinite.
1883	E. P. S. ... ..	H. Morton ... ..	90	...	Results very variable. Mean of one week's work. Current not kept constant.
1883	" ... ..	Aron ... ..	...	6 to 50	
1885	B. T. K. ... ..	Forbes ... ..	80	69	
1886	Farbaky and Schenek	Waltenhofen ... ..	91·7	78·7	Current maintained constant during charge and during discharge.
1886	E. P. S. ... ..	Drake and Gorham ...	90	80	
1887	" ... ..	Haebelin ... ..	92	...	Lead spirals painted over with salts.
1887	Fitzgerald ... ..	Lea ... ..	91	...	
1887	" ... ..	Huber ... ..	...	88	
1887	C. Smith ... ..	Miller ... ..	80	...	Normal currents used in charging and in discharging.
1888	Huber ... ..	W. Kohlrausch ... ..	90·7	78·4	
1889	Farbaky and Schenek	Waltenhofen ... ..	88·1	77·4	
	Tudor ... ..	W. Kohlrausch & Heim	94	82·4	Charging and discharging currents rather more than twice the normal.
1889	" ... ..	" "	77	64·7	Cells allowed to rest for 160 hours after charging.
	" ... ..	" "	81·4	71·7	Cells first completely discharged by the external resistance being gradually diminished to nought.
	" ... ..	" "	90	80	The positive plates of these Tudor cells are first formed by Planté's process, then the holes in the grids are filled with minium, and the forming continued. The negative grids are not formed at all, but merely have the holes in the grids filled with lead oxide.

regulation, and the circuit broken during discharging and during charging the moment the P.D. reached certain pre-arranged values.

We had next to adopt a criterion by which to settle when a charge or discharge could be said to be completed. Such a criterion may be made to depend on a variety of changes that take place in a cell, three of which are in common use—viz., change in the specific gravity, gassing, and change in the P.D. In the case of the cells tested by us, and which have more liquid in proportion to the plates than is usually the case, the change in specific gravity from charge to discharge is from 1.2 to about 1.17; and, as our experiments show that the change is directly proportional to the time, when the current is kept constant, the change in the specific gravity per hour is only about 0.002, which

Potential difference per cell, charging with 9 ampères. End of charge.

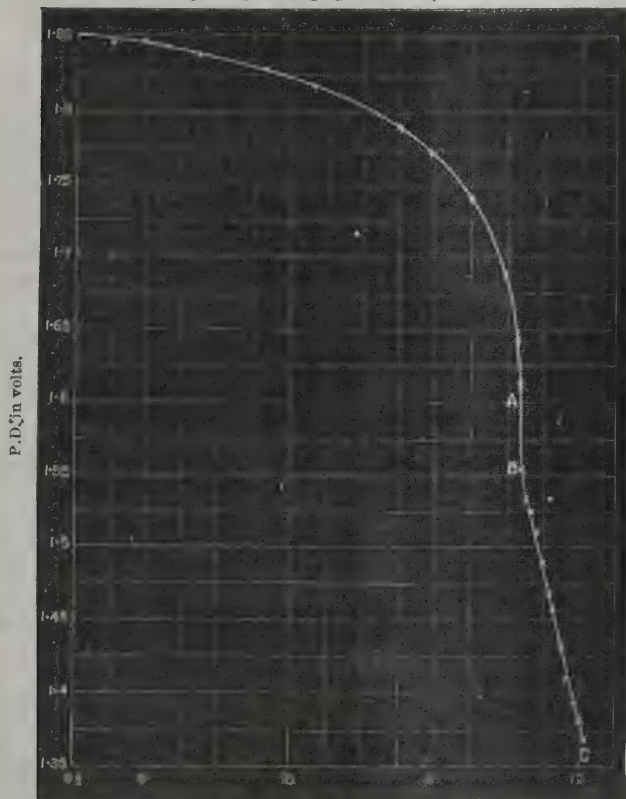


Time in hours from beginning of charge.

FIG. 1.

is far too small to be read very accurately with ordinary hydrometers. But it is known the fall in the E.M.F. of the cells at the end of the discharge is very rapid, so that half an hour more or less in the time of discharge produces a great difference in the value of the

Potential difference per cell, discharging with 10 ampères. End of discharge.



Time in hours from beginning of discharge.

FIG. 2.

E.M.F.; hence it follows that, if a specific gravity test were alone employed with our cells as a criterion of charge and discharge, it would be necessary to read the specific gravity accurately to less than 0.001 at the end of the discharge. The

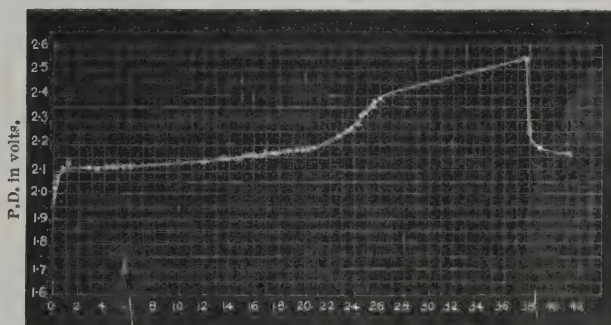
amount of gassing is also far too rough a test, and cannot be employed at all in the discharge, hence we were led to resort to the variation in the P.D.

A number of experiments were now made on two of the cells, in order that the exact shape of the curves of P.D. at the end of the charge and discharge might be ascertained. The curve shown in fig. 1 is the end of the P.D. curve for one cell on charging with 9 ampères for 14 hours; from which we see that the rate of variation of the P.D. with time is greatest when the P.D. is about 2.36 volts, indicated by the point, A. In fig. 2 is shown the curve of P.D. during the last 3½ hours of discharge with 10 ampères, the discharge being continued for 12 hours. In this particular experiment the discharge was allowed to continue until the P.D. fell to 1.365 volts, indicated by the point, c, which is far lower than we have dared on any other occasion to allow the P.D. to fall. At about 1.8 volts the P.D. curve begins to fall pretty rapidly, and the slope of the curve, or the rate of diminution of the P.D. with time, goes on increasing until the P.D. has fallen to 1.6 volts, indicated by the point, A, on the curve in fig. 2. Here

$\frac{dv}{dt}$  per cell has reached a value 1.4, v being measured in volts and t in hours. Below this the curve has a shape that has not hitherto been noticed, for when the P.D. per cell has reached 1.556 volts, indicated by the point, B, the curve suddenly alters its shape, becoming the straight line, B, c, with a less inclination to the axis of time,  $\frac{dv}{dt}$  being for this line only 0.44.

Potential difference per cell, charging with 4.52 ampères.

Charging circuit broken.

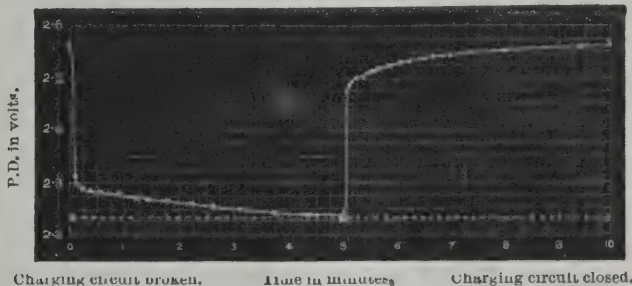


Time in hours from beginning of charge.

FIG. 3.]

Just as we have in the curve in fig. 2 continued the discharge much below the usual limit, so we examined what would take place if the charging was also prolonged much beyond the usual limit. Curve 3 shows the rise of the P.D. when the charging at 4.52 ampères was continued for 37½ hours, 25½ hours being sufficient to fully charge the cells with this constant current of 4.52 ampères—that is, to charge them until the P.D. per cell was 2.4 volts. It will be observed that whereas the volts rise from 2.25 to 2.38 between 23.1 and 25.5 hours—that is, 0.13 volt per cell in 2.4 hours—the rise in the following 12.3 hours is only from 2.38 to 2.55 volts: this is only 0.17 volt. The continuation of the curve shows the drop of P.D. on breaking the charging circuit; there is an instantaneous fall of 0.28 volt per cell, and a further fall of 0.1 volt in the E.M.F. in two hours.

Potential difference per cell, charging with 9 ampères.



Charging circuit broken.

Time in minutes

Charging circuit closed.

FIG. 4.

The curve on fig. 4 shows on a larger scale this drop on breaking the charging circuit when the cells are very well charged, leaving it broken for five minutes, and then closing it again; the charging current in this experiment being 9 ampères. There is, we see, a nearly instantaneous drop of the terminal P.D. per cell from 2.56 to 2.31, then a steady fall in the E.M.F. from 2.31 to 2.24 volts in five minutes. On reclosing the charging circuit at this moment, there is an instantaneous rise of the P.D. to 2.48 volts, and then a slow rise to 2.56 volts in five minutes; so that after reclosing the charging circuit it took, in this experiment, the same time for the P.D. to recover the value it had just before breaking as the time during which the circuit remained broken.

Experiments were also made on the time rise of the E.M.F. on stopping the discharge. Later on, however, the time rise of the E.M.F. on breaking the discharge circuit, as well as the time fall of the E.M.F. on breaking the charging circuit, for various currents, was measured in a far more sensitive way than in the early

part of this investigation; this subject will, therefore, be left until farther on in this paper.

On starting a discharge the P.D. generally falls slightly to the value that is maintained fairly constantly during a long portion of a discharge. After a prolonged rest, however, we have found that the P.D., on the contrary, shows a *decided rise* at the commencement of a discharge, and that it is not until the third discharge takes place that the curve resumes its normal character with the slight drop in the value of the P.D. at the commencement of the discharge.

## II.—EFFICIENCY.

In the earlier of the experiments made by us on the efficiency two distinct groups, each of 10 cells, were employed. The current passing through the two sets of cells also passed through two platinoid strips, and the P.D. at the terminals of each of these platinoid strips was measured by a suitable low resistance galvanometer, whose indications, therefore, measured the respective currents passing through the two sets of cells. The P.D. at the terminals of either group of cells was measured by means of a high resistance D'Arsonval galvanometer, which by means of a switch could be connected with the terminals of either of the two groups. The high resistance and one of the low resistance instruments have been absolutely calibrated very frequently during the past few years, by means of the silver voltameter, known resistances, and Latimer Clark standard cells. A special calibration was also taken of these instruments, both just before these experiments were commenced, and at their conclusion.

Group No. I. of 10 cells was first charged with 9.05 ampères and discharged with 9.933 ampères, there being four discharges alternated with four charges, without intermission, from January 8th to January 12th, 1889, both days inclusive. One of the observers was always present (day and night) to keep the current constant by hand regulation, to take frequent readings of the P.D. at the terminals of the set of 10 cells, to stop the charging when the P.D. per cell reached 2.4 volts and immediately start the discharging, as well as to stop the discharging when the P.D. per cell reached 1.6 volts, and instantly start the charging again, so that the cells were never left discharged.

We used the limits 2.4 and 1.6 volts per cell as the criterions for stopping respectively the charge and discharge since, as already seen, the slope of the charge and of the discharge curves are greatest for about these values of the P.D.

Next, Group No. I. was charged with 4.519 ampères and discharged with 9.933 ampères, twice, without intermission, from January 14th to January 19th, inclusive; the P.D. limit for charge being 2.4 volts, and for discharge 1.5.

And while the two sets of tests were being made with Group I., Group II. was first charged with 9.104 ampères, and discharged with 4.858 twice, without intermission, from January 9th to January 12th. And lastly, Group II. was charged with 4.519 ampères, and discharged with 4.858, without intermission, from January 14th to January 19th, both days inclusive.

Shortly, then, the tests were—

	Charge.	Discharge.
Group I. ... ..	{ 9 4½	... 10 ampères. 10 "
Group II.... ..	{ 9 4½	... 5 5 "

The coarse adjustment of the resistance for keeping the current constant was effected by means of resistance coils made of bare German silver wire suitable for standing large currents; the fine adjustment was performed by means of horizontal mercury troughs, through which the current passed, the lengths of the mercury in the wooden troughs through which the current passed being varied by copper bridge-pieces. This mercury trough arrangement forms an extremely convenient resistance for delicate adjustment by hand. To keep the current as constant as possible, a dynamo was not used to charge the accumulators under test, but they were charged instead from other accumulators of much greater storage capacity.

The general expressions for the ampère hours and watt hours given out by an accumulator are, of course,

$$\int_0^{t_1} A_1 dt, \text{ and } \int_0^{t_1} A_1 v_1 dt,$$

where  $A_1$  and  $v_1$  are the current in ampères passing through the accumulator, and the P.D. at its terminals at any moment, and  $t_1$  is the time in hours during which the discharge lasts. Consequently, if  $A_2$ ,  $v_2$ , and  $t_2$  have similar meanings for the charge, the complete expressions for the quantity and energy efficiency are, respectively,

$$\int_0^{t_1} A_1 dt + \int_0^{t_2} A_2 dt,$$

and

$$\int_0^{t_1} A_1 v_1 dt + \int_0^{t_2} A_2 v_2 dt.$$

In our experiments  $A_1$  has a constant value during the discharge, and  $A_2$  a constant value during the charge, so that the expressions for the quantity and energy efficiency reduce themselves to

$$\frac{A_1 t_1}{A_2 t_2},$$

which is very easy to calculate,

$$\text{and } A_1 \int_0^{t_1} v_1 dt + A_2 \int_0^{t_2} v_2 dt.$$

To obtain  $\int_0^{t_1} v_1 dt$  a time curve of the values of  $v_1$  is drawn

and integrated; similarly, to obtain  $\int_0^{t_2} v_2 dt$  a time curve is drawn

for  $v_2$  and integrated; then, multiplying the first integral by the steady value of the discharge current  $A_1$ , and the second integral by the steady value of the charge current  $A_2$ , we have, respectively, the watt-hours given out in the discharge and the watt-hours put into the accumulators in the charge.

After drawing a series of time curves for the P.D. in the various experiments already referred to, and integrating them with an Amster's integrator, we obtained the following results for the successive charges and discharges:—

### Group of 10 Cells—No. I.

Discharge at 9.933 ampères.		Charge at 9.05 ampères.		Percentage.	
Ampère hours.	Watt hours.	Ampère hours.	Watt hours.	Quantity efficiency.	Energy efficiency.
119	2,280	114	2,435	105	94
105	2,045	102	2,220	103	92
101	1,970	101	2,220	100	87
104	2,020	104	2,270	100	89
Discharge at 9.933 ampères.		Charge at 4.519 ampères.			
112.5	2,170	115	2,485	98	87
113	2,190	115	2,485	98	88

### Group of 10 Cells—No. II.

Discharge at 4.858 ampères.		Charge at 9.104 ampères.		Percentage.	
Ampère hours.	Watt hours.	Ampère hours.	Watt hours.	Quantity efficiency.	Energy efficiency.
154.5	3,005	138.5	2,910	111.5	103
141.5	2,770	129.7	2,820	109	98
Discharge at 4.858 ampères.		Charge at 4.519 ampères.			
143	2,785	141	3,075	102	90.5

Now not only are quantity efficiencies of 105, 103, 111, 109, &c., per cent. impossible, but energy efficiencies of 94, 92 per cent. are also too high, when accumulators are being charged and discharged at the maximum rate allowed by the manufacturers. Further, it is noticeable that for each set of tests both the quantity and energy efficiencies diminish on the whole as the tests proceed. These cells, like the other cells in the Central Institution laboratories, have been charged at regular times; and as the number of ampère hours taken out of them for ordinary laboratory work varies very much, the intervals between the periodic chargings are so arranged that on the whole the cells are charged up much more than they are discharged.

Hence at the commencement of these tests the cells had a large store of energy in them on which to draw in the discharges, the results of which are given in the preceding table. From this we learn this very important fact—that if accumulators be thoroughly well charged up before being tested, then five days' continuous charging and discharging alternately with even the maximum currents allowed by the manufacturers fails to give the normal quantity, or energy, efficiency.

It will be noticed that both the ampère hours and the watt hours are increased by diminishing the current employed. This is partly due to the fact that if a fixed P.D. limit per cell be employed either in discharging or charging, the cell is discharged until the E.M.F. is slightly lower, and charged until the E.M.F. is slightly higher for a small current than for a larger one.

## III.—AUTOMATIC CURRENT REGULATOR.

We think it possible that a neglect of the power that accumulators possess of drawing on a store of energy put into them in former chargings may have led experimenters to conclude that the normal efficiency of certain types of accumulators was greater than was really the case. To ascertain the *working efficiency* of the accumulators we were testing, it was clear that they would have to be charged and discharged alternately with a definite charging and a definite discharging current continuously for a much longer period than five days. And as this would be a very laborious operation if the current had to be kept constant day and night during this period by hand regulation, we proceeded to construct the automatic current regulating device shown in fig. 5:

A is a set of five accumulators under test, where B is a totally independent set of four used to provide the power for working the current regulator. C is a platinum strip of sufficiently large cross section and surface that no appreciable change of resistance can take place by the largest current—10 amperes—that flows through it in these experiments. D is a permanent magnet motor, the rotation of which in either direction turns the brass roller, E, F, very slowly in one direction or the other, the pinion and toothed wheel of the motor, combined with the small grooved pulley on the toothed wheel shaft and the much larger grooved pulley on the roller, causing the angular motion of the roller to be about  $\frac{1}{500}$ th of the angular velocity of the armature of the permanent magnet motor. The brass roller, E, F, is electrically divided into two halves by the ebonite disc, G, and little amalgamated discs at the ends of this roller turn with but little friction in mercury cups, H, I. Round each half of the roller are wound four bare platinum wires of No. 26 gauge, and each about  $4\frac{1}{2}$  feet long. Their lower ends are soldered to the brass roller, and their upper ends to the brass bar, J, K, small spiral springs (not shown in the figure) being introduced to keep the wires taut. The rod, J, K, is held up by a cord which passes over two pulleys, and to the end of which is attached the weight, L. An electric current entering at H follows the path, H, E, J, K, F, I, the path being longer or shorter depending on the amount of the platinum wires wound on the two halves of the brass roller. M is a solenoid, being, in fact, the coil of an A. and P. ammeter. N is the axis of which a rod, P, Q, was very delicately poised by its being supported by four very fine wires of No. 40 gauge, and each about one foot long. Two of the wires, R, on a plane at right angles to the path, joined together where they

When the cells, A, under test were being charged by means of a set of accumulators not shown on the figure, but attached to the leads, T and U, three copper bridge-pieces were put in to connect the mercury cups, 4 to 5, 2 to 6, and 1 to 3, respectively; whereas when the test cells were being discharged two copper bridge pieces connected the mercury cups, 2 to 3 and 5 to 6. The current passed, of course, one way through the cells, A, in charging, and the other way in discharging; but in both cases a positive current flowed, as indicated by the arrows, through the thick lead, V, the platinised strip, C, through H, E, J, K, F, I, through the thick lead, W, the thick lead, Y, the solenoid, M, and the thick lead, Z. As already explained, if the currents through this circuit exceeded in the very least 9 amperes, the core, P, Q, was sucked into the solenoid, M, until P made contact with R; whereas if the current fell in the least below 9 amperes, P, Q was pulled back by the spring, P, P', until P made contact with S. In the former case a small auxiliary current from the accumulators, B, follows the course, a, b, c, d, through the spirals, e—several in number, so as to carry the current, but made of extremely fine wire, so as to oppose practically no resistance to the free motion of P, Q—then from P to R, through f, the electro-magnet, g, and through h, back to the other pole of the battery, B. If, instead, P be in contact with S, then the current from the auxiliary accumulators, B, passes from P to S through the relay electro-magnet, i, instead of through the relay electro-magnet, g. In the former case the spring tongue, k, is attracted so as to make contact with M (M being in reality a mercury cup into which dipped a platinum point with which k was tipped), and in the latter case the spring tongue, l, is attracted so as to make contact with m. If k makes

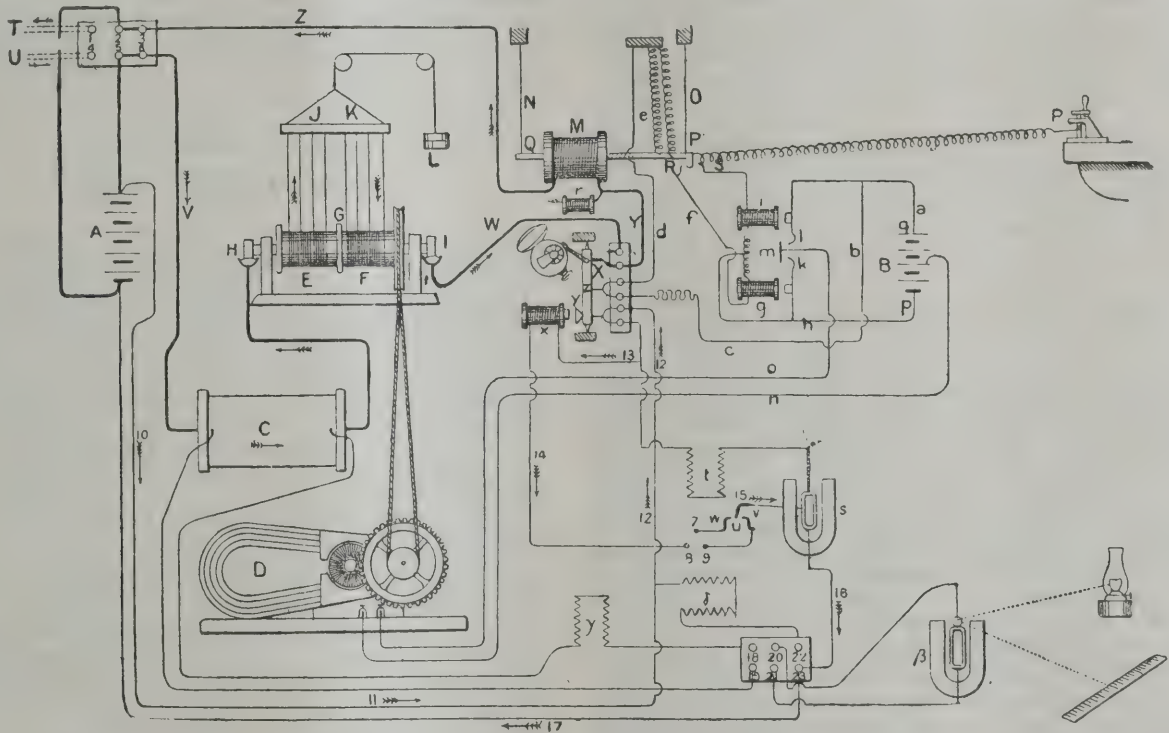


FIG. 5.—AUTOMATIC CURRENT REGULATOR, AND AUTOMATIC INTERRUPTOR FOR BREAKING THE CHARGING AND DISCHARGING CIRCUITS.

were connected with the rod at Q, but spread out at the top, and similarly O consisted of two wires. Thus, while the rod, P, Q, had great freedom of motion along its axis, it could not wobble sideways. This rod consisted of two pieces of brass at its ends, but the middle shaded portion was the well-annealed soft iron tubular core of the ammeter. A current passing round the coil, M, sucked in the core more or less against the pull of the antagonistic spiral spring, P, P'. This spring was made of platinum wire of No. 26 gauge, wound round a  $\frac{3}{4}$ -inch mandril, and when pulled out in position it had about 30 turns to the foot, and was over 4 feet in length. One end of the spring was attached to the rod at R, while the other, P', was fastened to a fine thread, which could be wound up more or less round a small roller and the tension of the spring very delicately adjusted.

At first the elasticity of this spring was not perfectly constant, but after about one month's use the pull it exerted when stretched to a given length became wonderfully definite, and the core, P, Q, could be adjusted so that for a current of exactly 9 amperes flowing round the solenoid, M, the projection at R remained midway between the contacts, R and S, without touching either. But on the current flowing round the solenoid, M, becoming very slightly greater, or very slightly less, than 9 amperes, the platinised projection of the rod at R made contact with either the platinised piece, R or S. The permanency that the spring eventually attained was so great that even when the apparatus had not been in use for two or three weeks, one had only to close the circuits to start the regulator, and no fresh adjustment whatever of this spring was necessary to ensure that the current would be kept absolutely constant at 9 amperes. This spring has, however, now gone the way of most bare fine platinoid wire, of breaking up into pieces.

contact with m, a positive current commencing from the middle of the accumulators, B, follows the path, n, the motor, through o, m, k, and back to the end of the accumulators, p; whereas if l makes contact with m, a positive current follows the path q, a, l, m, o, the motor, through n, and back to the middle of the cells, B.

Accordingly, then, as P makes contact with R or with S, a current is sent one way or the other through the armature of the permanent magnet, D, and the roller, E, F, is turned around one way or the other so as to unwind, or wind up, more of the wire and automatically alter the resistance in the circuit. Although the whole apparatus was home-made, and looked very rough, it was able to automatically keep the current constant to 1 part in 600 for days at a time.

As the charge was effected with 9 amperes, and the discharge with 10, a shunt, r, exactly nine times the resistance of M, was connected across M during the discharge, and as the automatic regulator kept the current through M constant at 9 amperes, it kept the current through the circuit constant at 10 when the shunt, r, was attached to M.

The necessity of using the relay electro-magnets, g and i, arose from the fact that the only suitable permanent magnet motor which was at our disposal was a laboratory hand magneto Gramme machine, which required a current of about one ampere to work it, and to obtain great sensibility, the contacts between P and R, or P and S, had to be too slight to carry such a current.

It was very interesting to watch the regulator, since the armature of the motor was almost always in motion, now making half a turn one way, now one turn the other. It may be mentioned that one turn of the motor armature shortened or lengthened each

of the platinoid wires by about the 62nd of an inch—that is, by less than the  $\frac{1}{1000}$ th of its whole length.

At first all sorts of plans were tried for keeping clean the surface of the mercury in the mercury cup, *m*; but alcohol floated on the mercury failed because it dried up, water was electrolysed, oil was carbonised, and a long conducting point adhered to each of the platinum points, *l* and *k*, and the auxiliary accumulators, *B*, were short-circuited. In despair, we left the surface of the mercury completely exposed to the air, and were surprised to find that that answered perfectly; a thickish layer of mercury and mercurous oxide formed on the top, but the platinum wires easily forced their way through, and always made good contact.

To avoid, however, all risk of accidents, cut-outs were introduced into various parts of the circuit; and to prevent the motor overwinding the platinoid resistance wires on the roller, *E*, *F*, and breaking them, should the current in the main circuit accidentally become much too small, as well as to prevent the motor unwinding the wires too far off the roller should the current become much too large, safety keys (not shown in the figure) were provided. If the red, *J*, *K*, were drawn down dangerously low, or allowed to go up too far, it touched one or other of the safety keys and broke the electrical circuits.

#### IV.—AUTOMATIC INTERRUPTOR FOR BREAKING THE CHARGING AND DISCHARGING CIRCUITS.

As it was extremely important that both the charging and discharging circuits should be broken at the exact moment when the P.D. in its rapid variation passed through certain specific values, and as in a long course of experiments, lasting for several months, it was quite possible that occasionally no one of the observers would be present at the exact moment, we arranged an interruptor to break the circuit automatically when the P.D. in charging reached 2.4 volts per cell, or 1.6 volts per cell in discharging. The automatic interruptor was arranged thus:—*s* is a D'Arsonval galvanometer, the coil of which, wound with platinoid wire of 154 ohms resistance, is joined in series with a resistance box, *t*, as a shunt to the accumulators, *A*, under test. Electric connection was made to the bottom of the coil by means of a fine spiral spring, too thin to introduce any controlling moment, while above the coil was suspended by a phosphor bronze strip  $\frac{1}{1000}$ th inch thick,  $\frac{1}{1000}$ ths broad, and  $1\frac{1}{2}$  inches long. This strip has seven twists put into it by means of a head moving in a tight collar, the coil being prevented from turning by a pointer, *u*, attached to the framework of the coil coming into contact with the stop, *v*. The thin phosphor bronze strip being very thin, it had very little torsional rigidity, and being set up as described, this instrument acted as a "set-up voltmeter"—a type of instrument proposed years ago by Prof. Perry and one of the authors of the paper for measuring with great accuracy a very small change in a P.D. With a definite adjustment of the resistance in the box, *t*, the platinum-tipped pointer, *u*, remains in contact with the stop, *v*, for all P.D.'s between the terminals of the accumulators, *A*, less than 2.4 volts per cell. When the P.D. reaches this value, the pointer at once leaves the stop, *v*, moves over through an appreciable distance, and makes contact with the platinum-tipped stop, *w*. With another definite adjustment of the resistance in the box, *t*, the pointer, *u*, remains in contact with *w* for all P.D.'s between the terminals of the accumulators, *A*, greater than 1.6 volts per cell, but the moment this value is reached the pointer moves away from *w* and makes contact with the platinum-tipped contact stop, *v*.

When charging, a copper bridge piece connects the mercury cups, 7 and 8, and when on the P.D. at the terminals of the accumulators, *A*, reaching 2.4 volts per cell, the pointer, *u*, passes over and makes contact with *w*, an instantaneous small current is sent by the accumulators, *A*, through the electro-magnet, *x*, which, attracting the armature, *y*, downwards, tilts the spindle, *z*, and thereby lifts *x* and the other two contact forks out of the three sets of mercury cups, thus breaking all the circuits. The tilting of the spindle, *z*, also brings a camel's-hair brush into contact with the balance of a watch, and stops it at the moment the charging is completed.\*

In discharging the cells, *A*, mercury cup 7 is connected to 9 instead of to 8. During the discharge the pointer, *u*, rests against *w*, and on the terminal P.D. of the cells falling to 1.6 volts per cell, the pointer moves over, comes into contact with *v*, and an instantaneous current passes round the electro-magnet, breaks all the circuits, and stops the watch. The course of this instantaneous current at the end of the charge and discharge is indicated by the arrows numbered consecutively 10, 11, 12, 13, 14, 15, 16, and 17.

To prevent any sluggishness in the action of this interruptor from a possible sticking of the pointer, *u*, against the contact stops, *v* or *w*, the pedestal supporting the set-up galvanometer, *s*, was kept in a constant state of slight vibration by the going of an American clock works that were placed on this pedestal.

#### V.—AMMETER AND VOLTMETER.

There remain only to be described the ammeter by means of which the current passing through the accumulators could be measured from time to time in order to see whether the automatic

regulator was doing its duty, and the voltmeter for frequently measuring the P.D. at the terminals of the accumulators, *A*, under test. As the current had only to be very occasionally measured, one D'Arsonval galvanometer, *B*, was employed for both purposes. Its coil was wound with platinoid wire of 52 ohms resistance, and suspended in the way that has been already described,\* which enables the deflection from one end of the scale to the other to be absolutely proportional to the current. The top suspension was a phosphor bronze strip  $\frac{1}{1000}$ th inch thick,  $\frac{1}{1000}$ ths wide, and about  $1\frac{1}{2}$  inches long; while electric contact was maintained with the bottom of the coil by means of an extremely fine *A*. and *P*. spring, offering no appreciable torsional rigidity. The permanent magnets employed belonged to an old magneto machine, and into the cylindrical space between their poles, in which the Siemens armature formerly turned, was put a coil made of the right shape to suit the curved ends of the magnets without it being necessary to employ any soft iron pole pieces. Experiment showed that the deflection right across a scale 2 feet 9 inches long, the zero for no current being at one extreme end, was rigorously proportional to the current—a result which, as has been already pointed out, is far from being obtained with D'Arsonval galvanometers as usually constructed.

When it was desired to measure the current passing through the accumulators, *A*, a rocking switch was turned so as to connect mercury cup 18 to 20 and 19 to 21; whereas when it was the P.D. at the terminals of the accumulators that was to be measured, the rocking switch was turned so as to connect mercury cup 20 to 23, and 21 to 22. In the former case, with a resistance of 264 ohms on the resistance box, *γ*, a current of 10 amperes passing through the cells and platinoid strip, *c*, produced a deflection of 500 scale divisions, or 50 divisions per ampere; while, with a resistance of 71,570 ohms in the resistance box, *δ*, a P.D. of 10 volts at the terminals of the five accumulators, *A*, under test produced the same deflection; so that 50 divisions corresponded then with 1 volt.

(To be continued.)

#### NEW PATENTS—1890.

10125. "Improvements in electric cut-outs or apparatus for controlling the flow of currents of electrical energy." J. L. KIMBALL and H. C. WIRT. Dated July 1. (Complete.)

10134. "Improvements in covered or insulated electric cables or conductors, and a compound therefor." J. Y. JOHNSON. (Communicated by J. H. Cheever, United States.) Dated July 1. (Complete.)

10137. "Obtaining motive power by a method and means, or apparatus in connection with any mechanical or electrical motor, or combination of both." P. H. WILLIAMS. Dated July 1.

10179. "Improvements in telephone call devices." H. J. HADDAN. (Communicated by F. R. Spalding, United States.) Dated July 1. (Complete.)

10181. "Improvements in secondary batteries." T. M. FOOTE. Dated July 1. (Complete.)

10183. "Improvements in electrical cut-outs, and fixtures connected therewith." H. H. LAKE. (Communicated by S. Bergmann, United States.) Dated July 1.

10187. "Improvements in or appertaining to self-exciting electric generators." W. P. THOMPSON. (Communicated by W. Stanley, Jun., and O. B. Shallenberger, United States.) Dated July 1.

10211. "Improvements in electric primary batteries." V. FABRIS. Dated July 2.

10229. "Improved means for decomposing sewage water by oxidising zinc by electric current." A. GREEN. Dated July 2.

10252. "Improvements in electric railways." J. P. BAYLY. (Communicated by T. A. Evans, United States.) Dated July 2.

10271. "An improvement relating to medico-electric batteries." N. MITCHELL. Dated July 2.

10276. "Improvements in electric search lights and in mechanism for feeding the carbons." H. J. ALLISON. (Communicated by B. B. Ward, United States.) Dated July 3.

10305. "A combined electrical comb-curler and curling tongs for hair." W. H. FASSETT. (Communicated by R. Scott, United States.) Dated July 3.

10309. "An improvement in adjusting electric light suspenders." A. LUCAS and E. SUNDBORG. Dated July 3.

10316. "Improvements in joints for armoured electric conductors." J. D. F. ANDREWS. Dated July 3.

10342. "Cleaning knives. Intended to be called 'Coomer's electric knife cleaner.'" G. M. COOMER. Dated July 4.

10359. "Improvements in connection with the electric lighting of ships." T. W. WATSON and A. H. WATSON. Dated July 4.

10406. "Improvements in electrical measuring instruments." J. PERRY. Dated July 5.

10421. "An improved method or means for the prevention of accidents from the overheating of electrical wires." J. BRADFORD. Dated July 5.

10445. "An improved electric prod-pole." J. P. BAYLY. (Communicated by J. Burton, E. Roach, R. Mac Nair, W. P. MacNair, and C. Lanning, United States.) Dated July 5.

\* As it was undesirable to risk an expensive watch, we purchased one of the watches that could be then obtained in St. Paul Churchyard for 3s. 5d. This watch was very substantial, had a very strong hair spring which could not be easily damaged, and was an excellent time-keeper—far superior to many watches of a far more expensive character.

\* See paper on "Galvanometers," *Phil. Mag.*, July, 1890.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

5066. "Improvements in sockets or holders for incandescent electric lamps." P. A. NEWTON. (Communicated from abroad by A. Swan, of America.) Dated March 23. 8d. The holder is composed of insulating material of a plastic nature, such as papier maché, moulded preferably to the form of a truncated cone. The base of the cone is recessed to receive the base of the lamp, through which pass the insulated wires leading from the carbon filament to insulated contact plates or rings on the surface thereof. The holder is pierced with ducts or passages for the leading wires from the electric main circuit, and recesses are provided in connection with these ducts containing contact plates or terminals. 19 claims.

5623. "Improvements in and connected with telegraphic apparatus for transmitting orders or other communications," G. A. CALVERT. Dated April 2. 11d. Consists in applying to the receiving instrument of the telegraphic apparatus a device to cause a bell or other sounder to sound or continue sounding in the event of the person receiving an order or communication making a mistake in the direction in which he moves a lever or other part when obeying the order or acting in consequence of the communication. 5 claims.

6728. "Improvements in the method of and means for the distribution of electrical energy by alternating currents." GISEBERT KAPP. Dated April 20. 8d. Claims:—1. In a regulating transformer, subdividing the primary or thin wire coil into sections and connecting each of the sections with a multiple contact switch, substantially as and for the purpose hereinbefore described and as indicated by the drawings. 2. A regulating transformer in which the induction through the secondary or thick wire coil is varied by altering the relative positions of the two coils and their cores, and of a third or intermediate core, substantially as described and as illustrated by the accompanying drawings. 3. A regulating transformer in which the induction through the secondary or thick wire coil is varied by the motion of a movable magnetic bye-pass, substantially as described and as illustrated by the drawings.

7600. "Improvements in electric indicators." B. C. C. CANT. Dated May 7. 6d. Consists of a new form of armature which bears on its outer side a small lug and a new form of flag, having at the apex of a circle a small curved lug which engages and is supported by the lug on the armature when by a quick motion of the electric current the lug is disengaged and the flag falls, indicating in which room or place the circuit has been made. There are various devices for better adjusting the correspondence of parts. 1 claim.

7719. "Improvements in electric or galvanic elements or cells." Dr. P. SCHOOP. Dated May 8. 6d. Claims:—1. An electric or galvanic element or cell having an acid or saline exciting body or electrolyte in a solidified or thick gelatinous state produced by adding water glass (i.e., silicate of potash or of soda) to a solution of an acid or of a saline substance, substantially as described. 2. An electric or galvanic element or cell having a solidified or thick gelatinous alkaline exciting body or electrolyte produced by adding to an alkaline liquid a solution of a salt of iron, such as sulphate of iron, either alone or mixed with hydrate of soda or water glass, substantially as described. 3. The production of an exciting body or electrolyte, such as hereinbefore referred to, by the conversion of an acid or saline solution into a solidified or thick gelatinous mass by means of a solution of water glass, substantially in the manner described for the purpose specified. 4. The production of an exciting body or electrolyte, such as hereinbefore referred to by the conversion of an alkaline solution into a solidified or thick gelatinous mass by means of a solution of a salt of iron, such as sulphate of iron, with or without admixture therewith of hydrate of soda or of water glass, substantially as described. 5. In the production of an electric element or cell of the kind referred to, the use of fibrous substance, such as asbestos fibre, in the manner and for the purpose set forth.

## CORRESPONDENCE.

### Secondary Battery Manipulation.

I send the following experience in case it may be of any interest.

Last year I filled in the spaces between the plates of my accumulators with plaster of Paris and sawdust in a dry state, intimately mixed, and then put in the usual dilute acid to which a little carbonate of soda had been added. I used these cells in conjunction with a dynamo driven by a turbine for lighting purposes; they were last charged early in November of last year, and on returning here late in June, I found that they burnt the lamps at their usual brightness, and that the E.M.F. of each cell was just under 2 volts. I also found that

the cells had lost very little of the liquid through evaporation.

W. J. S. Barber-Starkey.

Knockshandoch, Glen-Isla, Alyth, N.B.  
July 9th, 1890.

### Lubricating Oils.

If, from the report in a contemporary journal of a recent case of litigation, arising out of some experiments with a particular kind of lubricating compound called *valdoline*, we may draw any conclusion from the evidence of the witnesses, especially one describing himself as a mechanical engineer, we shall probably be led to believe that this particular compound is an unfailing lubricant for such work as is included in electric lighting, or that, as stated in the evidence of the plaintiff company, it is a complete failure for electric machinery. But this brings the subject of lubricants before us for more general thought, and compels us to enquire into the particular advantages, special and general, claimed for innumerable compounds possessing ordinary and oftener extraordinary names, and, as a rule, very ordinary lubricating properties. For what particular object there should be such a desire on the part of oil sellers and inventors, as they often term themselves, to make their lubricants as complex as possible by mixing really good mineral oils with all manner of rubbish in the shape of acid fats and oils of animal and vegetable origin, is not easily explained. It can be supposed that every lubricant "inventor" has his own particular fancy of what constitutes a good lubricant, and maybe has the idea that by making the lubricant complex in character, and by giving it an attractive or, more generally, repulsive name, it will command a ready and profitable sale under "good pushing men."

If we follow the experience of those works where engines and machinery are running continuously from year to year, we obtain some reliable data as to the lubricants which give the greatest satisfaction, and it behoves those electrical engineers who have the charge of heavy and continuous-running machinery to follow, as far as may be practicable, the experience acquired by others under similar conditions. Now, what is the experience of engineers regarding lubricants? I have gone to considerable trouble to ascertain opinions of reliable men in many mills and factories, and who are not to be "bought" or bribed by the cleverest of oil touters, and they are unanimous in recommending pure hydro-carbon, or, as generally termed, mineral oils of various specific gravities, in proportion to the work being done. There are such things in the market as pure mineral lubricating oils, and can, I believe, be easily obtained at a reasonable price. One thing I would point out is that the purest oil put in a dirty tank or cask will most assuredly become gritty by the actual suspension of fine grit, generally fine silica, especially if the oil be very dense; and this is often the cause of sudden screeching bearings. The grit can be separated by washing the oil in water and allowing to settle; but it is best to avoid the cause by watching the barrels.

Probably the tricks of oil touters exceed any other calling in general engineering. It was actually admitted to me by an engineer in charge of an electric plant at an exhibition in London that the oil he used, and that most abundantly, was that which was "watered" the most! But jobbery of this kind should be completely quashed; not in lubricants only, but in bigger fields where it is known to exist, in the electrical world.

James C. Richardson.

### Telegraph Statistics in Australia.

In your issue of February 14th you publish certain statistics purporting to be the postal and telegraph statistics of the colony of New South Wales. As the figures you give are so entirely erroneous, I am desired by Mr. Cracknell, the Superintendent of Telegraphs, to

forward you the correct figures (attached), with the request that you will kindly correct the errors.

Arthur C. F. Webb.

FOR THE SUPERINTENDENT OF TELEGRAPHS.

Electric Telegraph Department, Sydney,  
June 9th, 1890.

#### TELEGRAPH STATISTICS.

	Corrected figures from official reports.	Figures as given in the ELECTRICAL REVIEW.
No. of stations	485	210
Total mileage of lines open for traffic December 31st, 1889	10,732	5,436½
Total mileage of wires open for traffic December 31st, 1889	22,606	9,921
Total mileage of lines opened during year	143	145½
Total mileage of wires opened during year	488	291
Total mileage of lines dismantled, ditto	102	145½
No. of local and inter-colonial telegrams transmitted	3,415,545	918,454
No. of cables from this colony per International cable...	10,271	...
No. of cables from this colony per New Zealand cable	9,746	...
No. of cables to this colony per International cable...	8,649	...
No. of cables to this colony per New Zealand cable	8,225	...
Revenue of telegraph department...	£186,861	...
Expenditure of telegraph Department alone	£178,931	...
Revenue of telephone department	£13,360	...
No. of subscribers on Sydney and district exchange	1,161	600
(In addition to this exchange there are exchanges at Newcastle, Maitland, Bulli, Wagga, and Albury)		
Total mileage of lines in progress...	293	11½
Total mileage of wires in progress...	400	23½

#### Electric Traction.

However faint Mr. Stove's praise of the Lineff conductor may be, I should like to ask for what reason the demonstration of its capabilities on 25th ult. is not to be regarded as conclusive.

The crucial points with regard to any sectional traction conductor are :

1. Its reliability.
2. Security to the public.
3. Efficiency, under which may be included the proportion of the power consumed by the picking-up apparatus, and so lost for traction purposes, and the underground and surface leakage.
4. Cost of maintenance.

To take these points in the order in which I give them, I will examine whether any difficulties may be expected to occur in a line of three or four miles on my system, that have not already been met with and overcome in laying a length of 75 yards.

1. *Reliability.*—Since the experimental line was laid down, in no instance has the contact with the conductor been lost, except when (the battery circuit on the car being disconnected) the dynamo has been stopped for the purposes of experiment. During the time the car has run a very considerable number of miles, and as the number of moving parts in the conductor is identical for a short or long length of line, it is absolutely immaterial whether the mileage is made up by many short runs or a few long ones.

2. *Security to the Public.*—Here again the fact of there being only one moving piece in the conductor makes a length of 75 yards quite sufficient for demonstration. No additional element of doubt is introduced by increasing the length of line. From the laws of probability it is clear that the chance of any one of  $n$  switches going wrong is greater than that of any particular one doing so ; so that in a line dependent upon separate switches for its action the uncertainty increases with the length. In the case of my conductor, however, there is no such increase, for the simple reason that the car, so to speak, carries its own

switch with it, and this switch having been demonstrated to work satisfactorily over runs aggregating many miles, it is clear that under this heading, as under the former, the length of each individual run is immaterial.

The existence of a subsidiary wave in my hoop iron, in addition to the main one occurring under the moving magnet, has been thoroughly tested for, and it is proved that there is no such subsidiary wave within the limits of the line I have laid down. That a principal wave  $\frac{1}{4}$ -inch high should induce a secondary wave at a distance of over 75 yards is, as I think you will admit, so very remote a possibility, that it is quite unnecessary to contemplate it.

3. *Efficiency.*—The power absorbed by the picking-up magnet is obviously a constant quantity, and bears a constant ratio (about  $\frac{1}{20}$ th) to the mean power required to drive the small car. It will be less than this on a full sized vehicle. No difference on this head can accordingly occur on a long line.

With regard to underground and surface leakage, a judicious application of Ohm's and Kirchoff's laws will enable satisfactory conclusions for a line three or four miles long to be drawn from observations made on a length of 75 yards.

4. *Cost of Maintenance.*—This, I admit, can only be arrived at by subjecting the conductor to the same conditions as would exist when it was in practical use. But let us see what this means. It would be necessary to run a number of cars for a year or two on a public road before any demonstration took place. If this is not a contradiction in terms, it is so obviously an utterly impracticable expedient, that no apology need be offered for letting events proceed in the reverse order.

With regard to speed, I am at a loss to know how the statement that we had run here at 30 miles per hour originated, as it is clearly an impossibility. My car is geared to run at eight miles per hour, which is the maximum that will be allowed in the streets. Considering that I can start the car, attain this speed, and bring it to rest, all within less than half the length of the track I have laid down, I certainly think my line is long enough to demonstrate the capabilities in the way of speed so far as tramway traffic is concerned.

There are still one or two points to consider in Mr. Baines's letter. In the first place, he seems to think that the same tests are equally applicable to the third rail (by which I suppose he means the parallel), the series, and accumulator systems. Now, sir, is not some distinction necessary? The parallel system being perfectly well established needs no demonstration of its general principles, and a new method of making the connection between the moving car and the conductor can be adequately tested by means of a comparatively short length of line and a single car. On the other hand, the series system certainly requires the use of at least two cars before it can justify its name. Again, an accumulator system cannot be considered as "demonstrated" till the life of the storage cells is determined, and the number of cars and length of track have nothing to do with this.

As to the points on which Mr. Baines wishes to be enlightened, I may say that rain, having no access whatever to the charged main, cannot possibly affect the uncharged surface rails, and that snow, whether wet or dry, will produce equally little result. With regard to clearing away snow, no great difficulty is to be feared. In America, where the falls are much heavier, the electric cars are provided with ploughs, and are able to run when horse cars are absolutely snowed up. In this country it is very rarely that the horse cars have to stop through snow, and the means already adopted for clearing the track in their case can also be applied with equal success to the magnetic rail of my conductor.

Mr. Stove's reply to Mr. Baines was, owing to my absence, sent on to you without being submitted to me, otherwise this detailed answer would have been forwarded last week.

A. Lineff.

July 15th, 1890.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## SECONDARY BATTERIES.

IN a speech before the recent meeting of the Old Students Association of the City and Guilds of London Institute, Dr. S. P. Thompson volunteered some remarks to the effect that the series of articles on storage batteries, written by Mr. A. Reckenzaun for the ELECTRICAL REVIEW, were, in his opinion, of the greatest value to electricians, and that he regarded the whole as a standard work on this special subject. These articles, many of our readers will recollect, commenced in 1886, and were completed in 1888; they contained in a concise form nearly all that was then known about secondary batteries; at any rate, as far as their practical working was concerned. Mr. Reckenzaun treated the subject broadly, and he illustrated his observations by an immense array of figures and diagrams, drawn from his own every-day practice. The paper on "The Working Efficiency of Secondary Cells," by Messrs. Ayrton, Lamb, Smith and Woods, which we are reproducing in another place, naturally contains much that has been said and proved by our contributor; it is, nevertheless, of considerable interest, inasmuch as it gives results of new laboratory experiments which not only confirm existing knowledge, but at the same time offer hints for further research in particular directions. Prof. Ayrton and his assistants confined themselves to efficiency tests with a set of 20 E.P.S. cells of the "1888 type," each cell containing seven plates, which are ordinarily charged at the rate of 9 and discharged at 10 ampères; their normal capacity being 130 ampère-hours, and the total weight 59½ lbs. These were charged with a constant current, a task which would have involved an almost intolerable amount of attention, as the experiments ranged over a long period; therefore an apparatus was constructed which regulated the resistances of the circuit automatically, and thus kept the current rate practically the same. This apparatus we illustrated on page 81 of our last issue; it is somewhat complicated, yet ingenious, and it deserves, as far as the main principle goes, the study of those who take an

interest in the automatic regulation of accumulators; a subject which, in practice, is still a long way off finality. Whether a well-made apparatus on the lines indicated in the Edinburgh paper would work without any hitch outside a well-organised laboratory is a question we cannot answer; but, on the face of it, it seems as rational as any we have seen adopted in certain central stations claiming to possess self-regulating devices for charging accumulators. A fine opportunity is now open for some inventive genius to produce an instrument which should give the desired effect with certainty, but without expensive or complicated details.

Concerning efficiency tests, the authors have obtained some remarkable figures; thus it is stated that the ampère-hour efficiencies range between 111 and 98 per cent., and the energy efficiencies between 103 and 88 per cent. From this we are to learn "that if accumulators be thoroughly well charged up before being tested, then five days' continuous charging and discharging alternately, with even the maximum currents allowed by the manufacturers, fails to give the normal quantity, or energy, efficiency." If five days is not sufficient, what should, then, be the correct period, and why should the accumulator first be "thoroughly well charged" without taking proper account of this charge? Cells of the 7L E.P.S. type are supposed to have a capacity of 130 ampère-hours when discharging at the rate of 10 ampères; but the authors, according to table No. I., have only taken 119 ampère-hours out at the first discharge, and then recharged it to 114 ampère-hours. Naturally it would take a good number of discharges to get rid of the large surplus which might originally have been contained in the cells, but of which no account has been taken. Table II. reveals the fact that 154·5 ampère-hours have actually been taken out at the rate of 4·85 ampères, consequently it may have been possible that the battery contained over 50 per cent. more at the commencement of the tests than the experimenters were aware of, and it seems to us inexplicable why Prof. Ayrton allowed such irregularities to be placed on

record, especially as in the division VI. of the paper an account of a more rational method is given on the results obtained with automatic apparatus regulating the work of five accumulators. The experiments on the effect produced on the capacity and efficiency of accumulators by prolonged rests form one of the most interesting parts of this elaborate paper. Five cells, thoroughly insulated to prevent external leakage, were periodically charged, left to stand idle, discharged at long intervals, and the effects carefully noted. "Rest," say the authors, "of an accumulator, although well insulated and fully charged at the commencement, alters the accumulator so that for the first few charges and discharges, after the rest, it is a much less valuable instrument than before. A week's continuous charging and discharging day and night, however, removes this effect to a great extent; the efficiency, however, still remains lower than before the rest." Again, "from all that precedes, it follows that the previous history of an accumulator produces an enormous effect on its efficiency. If, for example, an E.P.S. accumulator be over and over again carried round the cycle of being charged up to 2.4 volts per cell, and discharged down to 1.8 volts per cell, the 'working efficiency' thus obtained may be 97 per cent. for ampère-hours, and 87 per cent. for watt-hours; whereas, if the accumulator has been left for some weeks, then, although it was left charged, the energy efficiency for the first few charges and discharges will be as low as 70 per cent."

Everyone who has had to do with secondary batteries on a practical scale, knows that energy efficiencies of 87 per cent. under normal working conditions are not attainable, and that laboratory tests with a few cells cannot be relied upon as a basis for power calculations. No experienced engineer, not even the most sanguine seller of accumulators, would be justified in allowing more than 77 per cent. efficiency under the most favourable circumstances, and we have often pointed out that the expressions "ampère-hour efficiency, or quantity efficiency," have no meaning whatever, and should be dropped out of the electrician's vocabulary.

The authors carefully avoid advancing any new views on the chemical actions in secondary batteries, and content themselves with quotations from various sources. The sediment that "fell to the bottom of the cells" was analysed; but this is of no importance whatever. If some of the active material had been forcibly removed from plates at various stages of charge and discharge, and analysed immediately, the science of secondary battery reactions would have been enriched to a great extent. This the authors promise to do with the aid of Dr. Robertson, in Dr. Armstrong's laboratory, and the results of these investigations will be looked forward to with anxious interest by a large portion of the electrical fraternity. We have frequently expressed the hope that some competent chemist might take this matter in hand, and, if possible, remove the doubts which still envelope the whole subject.

The experiments on temperature variations, and on the resistance of an accumulator when charging and discharging, are worthy of careful perusal, and, with

the exception of the few deficiencies previously pointed out, the paper of Messrs. Ayrton, Lamb, Smith and Woods must be regarded as vastly superior to many to which we have listened of late at the Institution of Electrical Engineers. The concluding words of the authors, expressing the hope that they may be able to "present a graphical record of the life history of accumulators from their first formation to their death," have no doubt made the minds of the curious more curious, and the hearts of the faithful more faithful. Let us hope that both will be fully satisfied by the time these cells, born in 1888, come, after an eventful career, to their end.

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### "AN UPRIGHT JUDGE, A LEARNED JUDGE."

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"I HAVE difficulty in understanding how it is that a considerable number of able and distinguished men should have been persuaded to give their evidence as to the alleged insufficiency of Mr. Varley's description as an anticipation. To a considerable extent, the evidence of the witnesses of the Brush Company is made up of somewhat minute and verbal criticism on the expressions used by Mr. Varley; but, in so far as these gentlemen indicate an opinion as to the insufficiency of the description in its entirety, I think their conclusions are, in part, explained by their having misapprehended the question." These significant words were spoken by Lord McLaren in delivering judgment in the compound winding case, which we publish on another page, and the scientific experts against whom they were directed probably feel that they have escaped the more scathing criticism which their evidence deserved through sheer good nature on the part of the Judge. Misapprehension of the question is a gentlemanly and courteous mode of letting them down lightly; but, in one instance at least, this lack of acquaintance with Varley's specification and previous work led some of the Brush Company's witnesses to fairly overshoot the mark, and attempt to introduce into the case a matter which, on the face of it, was utterly absurd. We refer to the effort to make believe that a separate excitation was necessary with Varley's machine; in other words, that it could not be self-exciting. If the gentlemen who so tenaciously held to this view had only allowed their thoughts to wander back to the time when Varley discovered the reaction principle of the dynamo, they must have known that his inventive genius had been wholly centred on the production of machines which excited themselves; and was it likely that, with the knowledge and experience of after years, he would deviate from the principle on which he constructed his now historical machine?

This feature we have always considered to be one of the lamest points in the whole of the Brush evidence, and its introduction, with nothing in Varley's specification or drawings to suggest such an idea, seems to savour of something beyond mere misapprehension.

However, the whole judgment is so terse, forcible, and so completely in Varley's favour, that any attempt

on our part to bring out particular points would be useless, and we can only hope that with this decision we have heard the last of compound winding in its legal aspect. The attempt to create a monopoly seems to have been a stroke of the "venture nothing, nothing win," policy of the boldest kind, and was doubtless deliberately made with the full conviction that the electrical trade would submit to demands which have twice been clearly proved to be devoid of any legitimate foundation, rather than risk the glorious uncertainty of an appeal to the law. Luckily, however, Messrs. King, Brown & Co. refused to admit claims which they believed to be baseless, and, with a determination and pertinacity worthy of the Scotch race, they have succeeded in twice carrying their case. We are not aware at what determination the Brush directors have arrived, or what complexion of the matter they will present to their shareholders; but it seems too ridiculous to suppose that they will proceed to still further extremities, although the question may be reopened and obstinately prolonged till the expiration of Brush's patent.

Whatever the future may have in store, it must be admitted that great praise is due to the Edinburgh firm for their energy and perseverance in the face of obstacles which would have simply appalled many English manufacturers; and, as they have been put to great expense for the benefit of their fellow traders, it is scarcely credible that they will be allowed to go unrewarded, and we feel that an appeal to the electrical manufacturing interests to enable them to meet their heavy costs, should meet with a cordial response. After the previous trial it was hinted that a substantial testimonial to Mr. Varley would have been a graceful acknowledgment of his inventions, the benefits of which not he, but others, are reaping; and this we trust will now be forthcoming, for but rarely do we come across a case so well deserving recognition.

IN an article on this subject our contemporary *Industries* draws attention to the disturbances which may arise in telephone wires from the leakage from electric light circuits. The whole subject is being fought out before Parliamentary Select Committees, and possibly something definite may be decided in the matter. The sensitiveness of the telephone is well known, but somehow or other, in spite of the considerable network of electric light conductors radiating over the housetops, we do not hear of any serious complaints made by the subscribers to the Telephone Company in London. In America, again, where electric light and electric tramway circuits are rapidly spreading, but little is said of their disturbing effects; it is true that in the case of electric tramways alternating currents are not employed, but even so-called continuous currents are not as a rule so perfectly uniform as to be unable to set up an inductive action. The one certain cure is, of course, double-twisted conductors, and although the cure would be equally efficacious if either the electric light mains or the telephone wires were thus twisted, yet it would probably be cheaper to deal in this way with the tele-

phone circuits rather than with the electric light conductors. It might, perhaps, be suggested that the particular telephone circuits most affected should be duplicated and twisted; this would answer the purpose so long as local work only takes place, but if for exchange purposes a twisted circuit has to be connected to a single wire line, the advantage of the double wire at once disappears.

The Chicago *Illustrated Century* devotes an article to seriously advocating the Pennock primary battery

as a source of motive power for tramways. The inventor calculates that a 10 mile track with 15 cars on the overhead wire system costs \$215,000, the storage battery method \$200,000, cable \$885,000, and the Pennock plan only a fifth of the electrical and one-twentieth of the mechanical systems mentioned. Our contemporary gravely states that Mr. Pennock, by his primary batteries, can do away with the necessity of accumulators, dynamos, overhead wires, &c., and yet run the cars at a mere fraction of their usual cost. Moreover, the speed and power attained is claimed to be far greater than with the steam engine, as will shortly be shown by a train to be run between Chicago and New York by the inventor himself. The *Chicago Illustrated Century* is just 100 years behind the times, and Mr. Pennock will have to add another century to his age before that train with primary batteries knocks out steam.

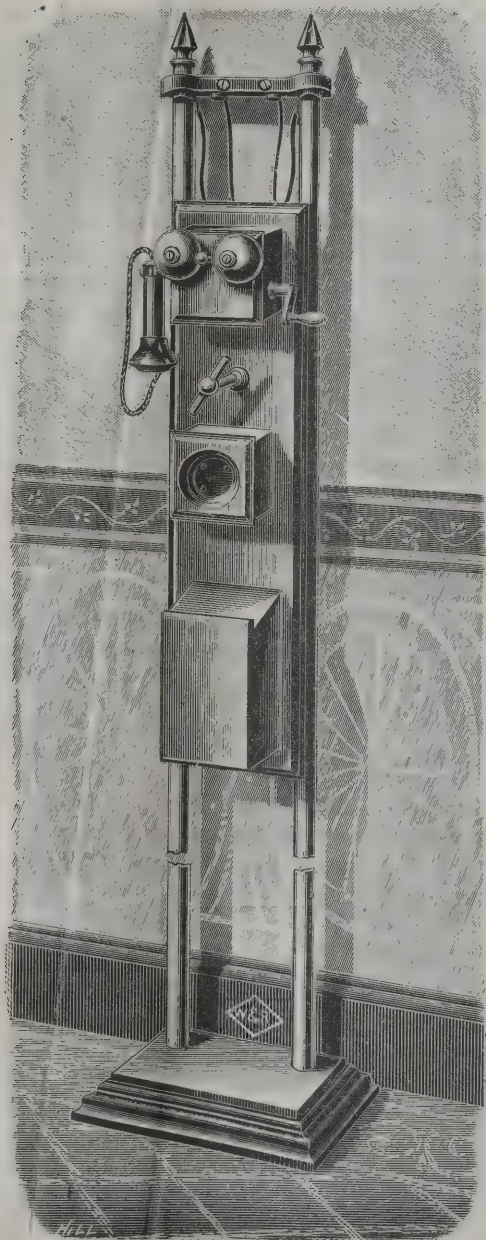
IN an action which took place last week in Manchester, for the recovery of the agreed cost of a small installation, the defence mainly rested upon the fact that as a few lamps went wrong in one portion only of the works, the installation was bad altogether. The faulty portion was in the bleaching room, where "chlorine" is freely evolved, and no notice appears to have been given to the contractors that there were unseen dangers. The plaintiffs, as will be seen from the published report, obtained the verdict. Now, this is not the first case, by many, where installations have failed in bleach and other works where "chlorine" is evolved. The action of the acid in the damp rooms is very rapid, all fittings go at once, and, in general, the insulated wire is attacked and the conductor destroyed. Sufficient care does not seem to have hitherto been employed in such works; and if the material used has been good and suitable, the manner in which it has been fixed has left it open to the attacks of "chlorine" and the speedy failure of the circuit. For such circumstances, special fittings and special wire are required, but of what kind and quality has not yet been precisely determined. Nevertheless it is difficult to understand what method of reasoning could possibly have induced the jury to arrive at its conclusion. On the face of it the evidence seems to have been as clear against the plaintiffs as one could well conceive; therefore we can only assume that the jury was influenced by facts not made public, or that the statements of Mr. Fawcus, the manager of a rival company, were considered to be of a biassed nature. In all cases of this kind it would be well to avoid bringing forward testimony which is not of a strictly impartial character.

Telephone Troubles  
from Outside Circuits.

**ADJUSTABLE TELEPHONE TRANSMITTER.**

THIS instrument is intended to enable persons of varying stature to adjust the transmitter of a telephone to the particular height most suitable to them. By the turning of a handle the carriage to which the ordinary instruments are attached can be moved up and down to any required point, and, by continuation of the brass rods through the floors of a building, it is possible to make a single telephone to serve for two or more floors. The connecting wires are of course long enough to allow of considerable extension.

Any type of transmitter can be equally well employed, as it is simply attached to the travelling carriage of the instrument, which also carries the bell and battery as shown.



Some five years ago we used an adjustable transmitter in our own offices, although not designed in the form here shown, which is controlled by Woodhouse and Rawson United, Limited.

**NEW DRILLING MACHINES.**

IN our issue of June 27th we referred to a new machine for drilling square, hexagonal, octagonal, or polygonal holes. We now publish a description of this machine, which has been invented by Messrs.

Ainley and Oakes, and perfected by Messrs. Tyler and Ellis. The original machine is similar to an ordinary drilling machine in the manner in which the spindle is driven and automatically fed downwards. The spindle, however, consists of three concentric parts. First, the outer sleeve carrying a bevel wheel, and driving the intermediate sleeve by means of a keyway and feather. Second, an intermediate spindle, having a set of five cams or cardanic circles formed upon each of its ends. There is a set of cams for each size of hole to be drilled. Third, an inner spindle carrying the tool and capable of being fed downwards either by hand or by an automatic feed, similar to the sliding spindle of an ordinary drilling machine.

The bearings or guides for the spindle consist of flat plates of hard steel made in halves and capable of being adjusted by right and left-handed screws, and suitable gearing is provided with handles and clamps. These plates are four in number, the two inner having round holes and engaging with the circular part of the spindle for drilling round holes. These are run back when the machine is drilling square holes, and the upper and lower plates, which have square holes in them, are screwed up so as to engage with the cams and give the required motion to the spindle. The pair of cams with which the square plates engage is determined by the position of the intermediate spindle, which may be raised or lowered by a hand lever and lifting gear.

This lever works in a quadrant, and is provided with five notches corresponding with the five sizes— $\frac{1}{2}$  inch to 1 inch—of holes which the machine can drill. The cams are set out as follows:—A square hole is made equal to the hole to be drilled. From any point in one side of the square, an arc of a circle is described with a radius equal to the side of the square. From the points where this arc intersects the sides of the square, other equal arcs are described completing the curve triangle. The square in which the cam is to revolve is then drawn, and from each of the vertices of the curve triangle two arcs are described which complete the figure. The point of the tool, which cuts with one edge only, must be situated beneath one of the angles of the triangle, and a different tool used for each size of hole.

In Messrs. Tyler and Ellis's improved machine, the spindle moves about the centre of a ball joint, the top end only being provided with a roller or wheel which travels round the inner edge of an annular template, being pressed outwards by a pair of spiral springs. The inner spindle carrying the tool serves a different purpose to that of the Ainley-Oakes machine. Here by lowering it, the size of the hole drilled can be varied with the greatest accuracy, while to drill a parallel hole, the whole head of the machine is lowered, moving in guides in the main framing. The templates can be easily changed, and any desired shape of hole cut. The tool is also so made that its cutting edge terminates on the centre line of the spindle, and is suitable for any sized or shaped hole. Both machines are capable, by the fitting of a cranked tool in the holder, of finishing and shaping the outsides of objects. The holes made by the machines are quickly and accurately drilled.

**IMPROVEMENT IN RAILWAY SIGNALLING APPARATUS.**

AN improved signalling apparatus for railways has recently been brought under our notice. Its object is to stop railway trains during foggy or snowy weather when the distant signal is at danger, and to dispense with the use of ordinary fog signals, and therefore with the men usually employed to place them upon the metals. The apparatus consists essentially of three parts. The first is a telescopic spring box platform placed on the ground in the centre of the 4-foot way; the second comprises an electric contact roller placed underneath the headstock of the engine; and the third is an electric bell and disc fixed on the footplate or engine platform. The telescopic spring box platform is attached to the sleepers, and works in conjunction with the ordi-

nary outdoor signals. It consists of two wooden boxes fitting telescopically inside one another, the outer or upper box having an overlapping lid resting upon two bent springs. Two similar springs are fixed at their upper ends to the underside of the overlapping lid. When the outer box is depressed in the manner to be subsequently explained, the lower ends of the two latter springs form an electric contact by being forced down upon a metal plate carried upon two supports. This act of making contact causes a current to flow through two wires connected with the metal plate, and to sound a gong attached to a suitable signal post erected in the 6-foot way. Upon the central part of the underside of the before-mentioned lid are fixed two brackets, to which is attached, by means of a pin, the upper end of a wire chain or cord. The lower end of this chain passes over two pulleys, and is connected to a pivotted quadrant which communicates by suitable leverage with the signal arm.

The electric contact roller consists of a roller mounted upon a hollow shaft, fixed in suitable bearings formed in the two arms of a forked metallic piece rigidly held by two springs, and having a shank which is bolted under the headstock of the engine. The roller is weighted at one end, and turns loosely upon the hollow shaft which carries a circular core of wood. This core has a portion of its upper part cut away, forming a flat surface which carries two metal bars with which a circular spring bearing against the core and arranged excentrically establishes a contact whenever the roller accomplishes an entire revolution. The two metal bars are connected at each end with two wires passing through the hollow shaft and leading respectively to the battery and to the bell arranged on the footplate of the engine.

The third apparatus comprises an electric bell, an indicator or disc connected with the bell by suitable springs, a cord to raise the indicator or disc, and a battery by means of which the bell and disc are operated when the contact roller passes over the spring box platform. It may here be mentioned that the latter platform is by means of the ordinary signal wire depressed so as to be level with the ground when the weather is clear and the signal open, and is raised during foggy or snowy weather, when the signal is moved to danger. In summer time the signal may be entirely disconnected from the platform which is then permanently held in a depressed condition, or the signal may be continuously operated in conjunction with the spring box platform for ordinary signalling purposes, whatever may be the state of the weather.

It may be well to explain the working of this apparatus. When the locomotive passes over the telescopic platform, the upper box is depressed by the contact roller, the circuit is completed, and the bell on the footplate of the engine is caused to ring, and the disc falls into the position of danger. The bell continues to ring and the disc remains at danger until the engine driver pulls the cord, thus interrupting the circuit and raising the signal to its safety position. Simultaneously with the depression of the platform, the second electric circuit is completed and the gong on the signal post sounds.

This system of signalling has been invented by Mr. J. A. H. Child, of East Greenwich, and Mr. J. Emery, of Erith. It has now been in operation on some sidings on the South Eastern Railway at Erith, for nearly a year, and has given complete satisfaction.

**Dissolution of Partnership.**—Mr. Wilhelm Lahmeyer, partner in the Deutschen Elektrizitätswerke zu Aachen (Garbe, Lahmeyer & Co.), retired from this firm on the 1st inst. The business will be carried on as usual by Mr. H. Garbe, but Mr. Lahmeyer will still have an interest in it. The reason for his withdrawal is to enable him to devote more time to the working out of inventions relating to central station lighting and the transmission of power. He purposes, therefore, to establish a new firm, which will work in conjunction with the Aachen firm.

## COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

THE Metropolitan Board of Works at Buda-Pest has at last agreed to grant the local tramway company a concession for laying down a trial line for the use of the Zipernowsky vertical system (already described in full in your journal), and the grant of a permanent concession for lines on this principle will depend on the results obtained on this trial line. It is to be hoped that electrical and engineering specialists will soon have the opportunity of learning the practical value of this interesting construction.

Meantime, the Buda-Pest electric City Line, laid down by Siemens and Halske, is making constant progress in the construction of new lines. It has already at its disposal a very extensive net of lines, and has consequently been requested by the municipality to introduce transfer tickets between the different lines. This request, however, has been declined, as the proprietors have not at their disposal the number of vehicles required for this service.

The first electric tramway in a Hungarian provincial town will shortly be commenced in the celebrated Hungarian watering-place Herkules-Bad. The Royal Hungarian Minister of Commerce has granted to Victor Lorenz, Engineer, the concession for the technical preparations for an electric line leading from the railway station Herkules-Bad to the watering-place of the same name. The concession is for one year.

The erection of interurban telephone lines makes considerable progress in Austria-Hungary, especially as regards the connection of provincial towns with each other. A telephone line has been recently arranged between the little towns Kásmark and Leibritz, which was put in action on the 16th inst.

Between Vienna and Prague, a second interurban telephone net is to be introduced, since the telephonic intercourse between these two towns has become very active. The new line is to be carried through the towns Brünn and Kolin.

The parish authorities of the Hungarian village Zichyfalva have resolved to light the streets of the place electrically. The installation is to be combined with the illumination of a steam mill situate at the distance of 1½ kilometres, so that the Dutch Colonisation Company, who are the proprietors of this mill, are to erect the installation at their mill and to supply the power from their steam engines. About 50 glow lamps will be furnished to private consumers. The entire installation is calculated for 150 glow lamps.

In the Bohemian town Teplitz, where the agreement with the gas company expires next year, a municipal electrical station is to be erected, for which several English and German and two Austria-Hungarian firms are tendering.

The Commission of Management of the Technological Trade Museum in Vienna has resolved to create a special school for electrotechnics with theoretical and practical instruction and a four-years' course of training. Its object is to train young men, having a sufficient preparatory education, as workmen of superior grades, foremen, &c., for electrotechnical works, lighting installations, &c. This special school will be the first of its kind either in Austria or Germany; it will possess a complete and excellent equipment, and it will be under the influence of a special committee of eminent practical men. If it is sanctioned by the Minister of Public Instruction, the first and second session of this school will begin in October next, the third on October 1st, 1891, and the fourth on October 1st, 1892.

A similar school, though on a more limited scale, has existed, for some years, in the Royal Hungarian Trade School at Kaschan, under the special management of Prof. T. F. Weyde. It is provided with a small electrotechnical workshop, which enables the pupils to become electrotechnicians by means of actual work.

The Vienna International Electric Company, which is to open in November the great electrical works, supplies provisionally current for illuminating the Pacher restaurant at the Vienna Exhibition of Agriculture and Forest Service, and for working a mill erected there by Ganz & Co., which is driven by an alternating current motor at the distance of  $1\frac{1}{2}$  kilometres from the central station.

## ALTERNATIVE PATH EXPERIMENTS.

By Dr. OLIVER LODGE.

I AM somewhat surprised at the tone of controversy adopted in places by Mr. S. A. Varley in your last issue, but as he has asked repeatedly for a re-statement of my explanation of the "alternative path experiments," I give it in what I imagine to be its simplest possible form.

The experiment consists in discharging a Leyden jar through a metallic circuit, two points of which are brought very near together, and observing the conditions under which sparks occur across the air between these points.

The explanation of the spark is as follows:—When a battery, or any form of current-propeller, is used to send a current,  $C$ , through a resistance,  $R$ , the difference of potential between the ends of that resistance is  $RC$ ; and if the current be strong enough, and the resistance high enough, this difference of potential may attain such value as can break down a determinate width of air gap.

In the case of a Leyden jar discharge, the current while it lasts is very strong, and the obstruction offered by a wire is very great, hence the conditions needed for a spark are likely to be satisfied.

The length of this spark (which I have elsewhere called a B spark, or a derived spark) is directly proportional to the maximum strength of the current passing, and to the impedance of the portion of the circuit intervening between the two points of derivation. The latter factor (impedance) depends directly on the frequency of oscillation of the discharge, as well as on the length and shape of the circuit; the former factor (current strength) depends on many more or less obvious things, but it depends also on the damping coefficient of the oscillations, in a way which at first sight might not be expected because of the fact that a current does not attain its maximum value till a quarter period has elapsed since the commencement of discharge (just as the swing of a released pendulum does not attain its maximum velocity till a quarter period after it has been let go); and this time though short, is long enough to permit some dissipation of energy, especially when thin iron wires are included in the circuit.

Applying this theory to my quantitative experiments they are numerically explained; and so, until some fresh experimental evidence in a disturbing direction is adduced, I see no good reason for re-opening the question. I have hitherto failed to see any such evidence included among Mr. Varley's allegations and surmises, and I really do not know why he declines to accept it, nor why he seems to feel some personal grievance in the matter of its adoption.

I am very willing to consider and answer any valid argument against the truth of such modern views concerning electrical phenomena as I have in various places endeavoured to expound, but until there is something substantial to attack, it is not much good keeping one's hand in by pummelling straw. The only point brought forward by Mr. Varley which seemed to present some plausible semblance of difficulty, viz., that about electric welding, I discussed, principally for its own sake, in the columns of your contemporary *Industries* for June 27th.

## CONNECTING LIGHTNING CONDUCTORS TO GAS AND WATER PIPES.

PROF. L. WEBER has an article in the *Elektrotechnische Zeitschrift* of July 4th, in relation to this subject. He says Prof. Lodge's investigations were restricted by two presuppositions, viz., that the duration of a flash is very brief and something like a millionth part of a second, ordinarily, and that the discharge is oscillatory; consequently the only inference that could be drawn from them is, that self-induction may be best avoided by exchanging the solid conductor for a flat or a hollow one, and by making the conductors branch as much as possible; further, that the best means of diminishing the dangerous spreading of the fluid, which is due to self-induction, is to augment the conductor's capacity, and that the most practicable method of doing this is to connect the conductors to the gas and water system.

Now, says Prof. Weber, there is indubitable evidence that the duration of a flash may vary within very wide limits. There are flashes which do indeed last only for the millionth part of a second, such as those observed by Dove with his revolving disc, and these are badly described as brief duration flashes. There are, besides, flashes whose duration is  $\frac{1}{2}$ -1 second; these are called long-duration flashes, and are further distinguishable from the others by their ruddy tint.

It is extremely probable that it is only long-duration flashes which have the power to communicate fire, although violent mechanical and physiological disturbances may be occasioned by those of brief duration. That the latter may possess oscillatory characteristics can, by analogy with the artificial sparks produced with a battery, and on the authority of Prof. Lodge's observations, be accepted; but that they possess them normally has yet to be proved.

That there may be long-duration flashes without these characteristics has been proved by photographs taken by the writer last summer, and described in the reports of the Berlin Academy. That long-duration flashes can also be oscillatory, he is not as yet in a position to deny, but the probability is against it. Naturally a multitude of variations on these two extreme types may be conceived.

It will now be seen, says Prof. Weber, that Prof. Lodge leaves untouched a class of flashes which is of long duration and not oscillatory, as well as another class whose characteristics are perfectly established. His investigations only take account of flashes whose characteristics are hypothetical, and their only practical value, therefore, is to confer fresh importance upon one of the oldest established types of conductor construction that, viz., in which the conductors are attached to the gas and water systems, and, possibly, to throw into relief the superiority of Melssen's system over that of Gay-Lussac.

The plan of construction for lightning conductors, the sufficiency of which has been made manifest by a century of use, will, Prof. Weber thinks, undergo no sensible alteration through Prof. Lodge's investigations, but rather will its usage be confirmed in every essential particular, and the difficulties which stand in the way of its wider adoption removed.

## AUSTRALIAN NEWS.

(FROM A SYDNEY CORRESPONDENT.)

THOUGH Sydney itself is very much behind its neighbours Melbourne and Brisbane, in the matter of central stations, still in the matter of electric lighting of country towns, New South Wales is much ahead of either Victoria or Queensland. As your readers doubtless know, Tamworth has for some time had the electric light installed by Messrs. Harrison & Whiffan, for the Crompton Co. The installation at the town of Young has just completed its anniversary, and the town authorities

have taken it over in good working order from the contractors, Messrs. H. H. Kingsbury and Co. The town of Moss Vale also has a small plant for public lighting, as also has Enfield. The lighting of the towns of Lambton and Penrith are proceeding apace under the hands of Messrs. H. H. Kingsbury and Co., who have secured the contracts for both places. The plans are prepared for the lighting of Katoomba, a small town in the Blue Mountains, the contract for which has also been secured by Messrs. H. H. Kingsbury & Co., and the wiring of several of the houses already completed. Tenders have been asked for the lighting of Redfern, a Sydney suburb, and the towns of Newcastle and Grafton. The towns of Tenterfield, Maitland, and others, and the suburbs of Ashfield and Campbelltown are all considering the question of electric lighting in real earnest. Taking things all round, it looks as if we were going to have a boom in electric lighting in New South Wales. An electric tramway is projected in Sydney, on the Thomson-Houston system, and orders have already been sent to America for the necessary equipment. There are several well-known English electricians located in Sydney just now, viz., Mr. Elwell, of Elwell & Parker, who has just given very good evidence before the Public Works Committee on the subject of electric trams; Mr. Callender, of the Callender Bitumen Company; and Mr. J. R. Williamson, late managing director of the Edison-Swan Company of Manchester, and who has now established himself here as managing director of the Williamson Electric Engineering Company. The want of a good consulting electrician has been felt here for some time, and Mr. Robert Oxlade, late of the Eastern Extension Company, and still more recently electrician to Messrs. H. H. Kingsbury & Co. and designer of the Young installation, has thrown himself into the breach, and already his action seems to be well appreciated. At a recent meeting of the N.S.W. Engineering Association a paper on Mr. Van Rysselburghe's system of distribution by "hydro-dynamos" was read and discussed. The reader of the paper must have had a rather uncomfortable time of it, as out of about a dozen speakers not one found a word to say in its favour.

The installation at Young is on the Thomson-Houston alternating system, and comprises three 500-light 16-C.P. dynamos of 1,000 volts potential, the transformers reducing this to 52 volts for the house circuits. There are two 25-H.P. Fowler engines, one only of which is being used at present to drive two dynamos.

The streets are lighted by 10 lamps, each containing six 16-C.P. incandescent lamps, and about 60 lamps of over 16-C.P.

The rates at present charged by the municipality are as follows:—One light, per annum, £1 10s.; two lights, £2 15s.; three, £4; four, £5 5s.; five, £6 10s.; six, £7 10s.; seven, £8 10s.; eight, £9 10s.; nine, £10 15s.; fifteen, £15 5s.; all over this number 10s. per annum each.

This is about equal to gas at 3s. 2d. per 1,000 c. feet, and gas cannot be produced in Young under 12s. 6d., which shows well for electricity in New South Wales. At present only about 700 lamps are being used.

The plant being put in at Penrith consists of two 30-N.H.P. compound Robey engines, driving two 650-light Thomson-Houston alternating dynamos.

At Lambton, two 25-N.H.P. Fowler engines are being used, with two 650-light Thomson-Houston alternating dynamos.

Tamworth at present has only a capacity of 500 20-C.P. lamps, the majority of which are used in street lighting, the dynamos being driven by two 12-N.H.P. semi-portable engines made by John Fowler and Co.

By the *Mariposa*, which arrived last week from San Francisco, came materials for starting an experimental line on the Thomson-Houston system. The cars are to arrive by next steamer.

Tenders for the supply and erection of plant for electric light at Bullock Island, Newcastle, gave some curious results. There were eleven tenders, ranging

from £2,720 to £6,275, there being over £1,000 difference between the lowest tender and the next lowest. Crompton & Co., Ganz & Co., Siemens Bros., The Brush Company, and the Manchester Edison and Swan were amongst the tenderers, the rest being local companies.

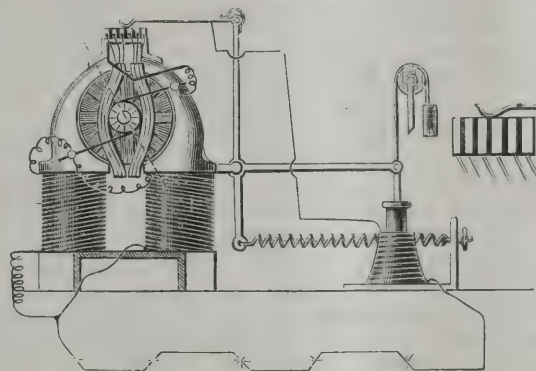
With regard to isolated electric lighting plants, the offices of the *Daily Telegraph* and of the *Evening News* are lighted, the latter having a fine set of Crompton-Howell cells; all the latest hotels have, of course, had the new illuminant installed. Circular Quay, the busiest part of the harbour, from which go the Orient, P. & O., Messageries, Maritimes, &c., mail boats, and most of the ferry boats, is well lighted by means of Brush arc lamps (shortly to be replaced by Brockie-Pell), as is Cowper's Wharf, Woolloomooloo, where the American mail steamers are wharfed.

June 1st, 1890.

### NEW REGULATOR FOR CONSTANT CURRENT DYNAMOS.\*

THE method of regulating constant current machines, illustrated diagrammatically in the cut, consists in the application of a set of demagnetising or opposing coils around the armature, in combination with a device for varying the current in the coils or varying the number of convolutions through which the current passes.

In this machine the core of the armature contains so much iron as not to become saturated when under load. The field magnets are wound so as to operate nearly, if not quite, to saturation. The field coils are connected in multiple, and are placed, as shown, in the main circuit. In order to prevent, as far as possible, sudden changes in the magnetism of the fields, Prof. Elihu Thomson, who is the inventor of the regulator, proposes to make the field magnetism the resultant of the magnetising effect of two or more field magnet coils. These are to be placed in separate circuits having different



self-induction. The difference of self-induction in the two coils of the branches may be obtained by giving a different number of turns to the coil. The current which passes in the two coils may be made equal by having the coil resistances equal, or by adding resistance to the coil branch which has the least resistance, as is indicated to the left in the diagram. The main portion of the regulator consists in the stationary set of coils wound about the armature. These when in circuit convey current in a direction to neutralise or tend to neutralise the induced magnetism of the armature as produced by the field magnets. It is only requisite that this opposing action have a value such that under any conditions the machine yields its normal current and an electromotive force just sufficient to maintain that normal current. A moving arm at the top slides over a set of contacts connected with the sections or successive turns of the coils, as shown. This contact arm is controlled by a lever, actuated by a magnet core against the counter action of a balance weight and spring. The last-named coil is made responsive to

\* *Western Electrician.*

the variation of the main current. The connections are such that when the current on the circuit increases above the normal, the arm at the top is shifted to bring into action the stationary coils about the armature. This produces an effect which opposes the effect of the magnetism of the field upon the armature, and cuts down the electromotive force. When the current falls, the regulator acts to cut out turns of the stationary coils. This gives stability of current strength under varied conditions, either with all the lights in circuit or with a lessened number.

### THE BIRMINGHAM BRISTOL ROAD ELECTRIC TRAMWAY.\*

THIS tramway forms one section of the Birmingham Central Tramways Company's system, and extends from the city along Suffolk Street, Bristol Street, and Bristol Road to Bournbrook, being three miles in length, and double line throughout. For about twelve years the above route was worked on the 4 feet 8½ inch gauge as a horse tramway, but having become very dilapidated and dangerous, it has recently been reconstructed to the same gauge and in a similar manner as the remainder of the company's lines, in connection with which a generating station has been erected at Bournbrook for the purpose of enabling the accumulator system of electric traction to be adopted.

The charging station, 75 feet long and 63 feet wide, where the cars are relieved of the exhausted batteries and supplied with charged ones, forms the front of the dépôt, and contains four lines of rails, which run through it into the car-shed behind, which is 100 feet long and 63 feet wide. The whole of the trucks in the car-shed and charging station are provided with pits, so that an examination can be made of the motors, gearing, and brakework, wherever the car may be standing. For the removal of the cells to and from the cars there have been constructed four hydraulic elevators, with eight shelves to each elevator, capable of storing sufficient cells for sixteen cars, besides which additional storage is provided in the accumulator room, where platforms are fixed to accommodate sufficient cells for two extra cars. These can be charged at the same time as the cells on the elevator cages, which are not closed in, but are open all round, so that the cells may be thoroughly under control and examination. Underneath the whole area occupied by these elevators is a chamber which facilitates examination of the cylinders, rams, and connections, and enables the cages to fall below the floor level.

The engines and boilers are in duplicate, and each boiler is capable of generating steam for one engine, each engine being guaranteed to deliver 100 horsepower on the flywheel. The two boilers are of steel, multitubular, of the "economic" safety type, 12 feet 6 inches long and 7 feet 6 inches diameter, each with two flues 2 feet 4 inches diameter.

The dynamos, two in number, are in the same room as the engines, and are duplicate of each other. They are of the Elwell-Parker continuous current type, shunt wound, each to give 120 volts 500 ampères, at an approximate speed of 540 revolutions per minute, and do the whole of the work, charging accumulators for twelve cars, the lighting of the dépôt, and the current supplying an 8-unit motor, which drives the machine tools. Dogs and slides are provided for tightening up the belts when required. The brushes are arranged to bear lightly upon the commutator, and are carried upon a rocker, which rotates to permit its being set in the best position, the brush holders being fitted with insulated "hold-off" catches. Two spare armatures will be provided to fit either of the two dynamos. Resistance coils and switches are provided for maintaining a constant electromotive force at the dynamo terminals.

From the positive terminals of the dynamos connection is made to the main switchboard, also in the engine room, provided with two main Cardew voltmeters, ammeters—600 ampères each—main dynamo switches and fuses, and distributing switches and fuses. On leaving the main switchboard the cable rises up to the tie-rods of the roof, along which it is conducted in a hard wood casing to the switch room, adjoining the accumulator room and the hydraulic elevators into which the cable drops, and is distributed among five regulating boards, one for each of the elevators and one for the accumulator room. Each board is fitted with ammeters, switches, fuses and adjustable resistance coils sufficient for eight circuits, *i.e.*, the eight shelves of the cage or hydraulic elevators, and carries up to 50 ampères. The resistances are arranged so as to be capable of maintaining a constant charging current through each set of cells. A voltmeter and multiple pole switch are provided to each board for measuring the electromotive force of any set of accumulators. From one of these regulating boards connection is made with the platforms in the accumulator room, the leads from the remaining four being taken overhead along a division wall to the vertical copper strips, attached to the castings guiding the hydraulic cage elevators. These vertical strips run from top to bottom of the guides, and are electrically connected to the batteries on each shelf by spring contact blocks attached to the cage, rising or falling with it, and sliding against the copper strips. After the current has passed through the batteries on the cages, it returns by means of similar copper strips on the opposite guides to the negative lead, then through the negative terminal fuse blocks, and on to the dynamo. There are also provided portable voltmeters for testing single cells, tachometers for indicating speed of dynamos, and hydrometers for testing the specific gravity of the acid solution. The accumulators, secondary batteries, or storage batteries, are of the Elwell-Parker type, contained in vulcanite cells filled with dilute sulphuric acid, and are composed of thin lead grids, filled with a paste of red lead or minium, and placed vertically in the cell. There are 19 grids or plates in each cell, 10 negatives and 9 positives, each plate being about 8½ inches by 6½ inches. The plates are kept apart by means of vulcanite insulators, and sufficient space is left between the plates to prevent their being short-circuited in case any of the paste pellets should happen to fall out of the perforation of the grids. When placed in the car, or when being charged, eight cells are placed in a teak tray and permanently connected, three of such trays forming one of the four groups into which the whole battery—when in the car—is divided for controlling purposes. There are 96 cells to each car, giving a total electromotive force of about 192 volts, and requiring a current of about 35 ampères to charge them, an operation which lasts about 10 hours. The hydraulic cage elevators are so constructed that the cells can be removed any time, and the operation of charging is commenced by the automatic connection, made directly the trays are removed from the cars to the shelves of the elevators. The lighting of the sheds and shops is by means of 16 candle-power incandescent lamps distributed throughout the building, with wall plates for connecting with portable hand lamps. Two 200-candle-power lamps are fixed over the entrance to the charging station.

The cars—twelve in number—have been built by the Midland Carriage Company at Shrewsbury, the electrical and mechanical fittings being supplied by the Electric Construction Corporation from their works at Wolverhampton. The cars—which are very similar in appearance to the cable cars belonging to the same company—are 6 feet 3 inches wide and 26 feet 6 inches long, about 4 feet 6 inches at each end being occupied by the platforms, and are constructed to carry 24 inside and 26 outside passengers. They are carried on two bogie trucks, about 15 feet between centres, the framework being of I-iron strengthened by two King trusses. On the top of the cars reversible garden seats are provided, and inside, the usual longitudinal seats with a passage down the

\* Abstract from an article in the *Engineer*.

centre. There are six trays on each side of the car, and each tray holds eight cells, there being 96 cells altogether. The cells are of vulcanite, and the trays of teak, each tray carried on three runners fixed to the car floor. The cells in each tray are permanently connected up in series, and the positive and negative terminals are connected to brass plates attached to opposite ends of the tray. Between each pair of trays is fixed a spring copper contact block, V-shaped, screwed to the floor of the car, with the apex of the V pointing outwards, the wings of the V spreading laterally. When the trays are pushed into the cars, the two tips of the V pieces come into contact with the brass plates on the ends of the trays, and so the whole of them are automatically connected up. The 12 trays—96 cells—are arranged in four groups of 24 cells each, the whole of the cells in each group being permanently in series, and the four positive and four negative terminal leads are brought up to the switch used by the driver of the car, by means of which the four groups may be connected up with the motor in six different ways:—No. 0, all the groups separate and disconnected; No. 1, all the groups in parallel, but not connected with motor; No. 2, the four groups in parallel, all the positives being connected together and with the positive terminal of the motor, and all the negatives together and with the negatives terminal; No. 3, half the groups in series and half in parallel; No. 4, one group is cut out and the other three groups are connected in series; No. 5, the whole four groups in series. Thus it will be seen that the whole of the cells are always in use when the car is in motion, fair uniformity of discharge being maintained. When the switch handle is at the extreme end, the whole of the batteries are on open circuit, disconnected from each other and from the motor. On being moved into the first position, the batteries are all connected up and ready for work, but not connected with motor. This position tends to equalise the batteries (No. 1). The second position connects the batteries with the motor, but only gives one-fourth of the total electromotive force, and would be used probably when travelling on the level with a light load (No. 2). The third position gives half the total electromotive force (No. 3). The fourth position gives three-fourths of the total electromotive force, one group being cut out (No. 4). The fifth position gives the total electromotive force of the whole of the 96 cells, and would be used in going up-hill with a heavy load (No. 5).

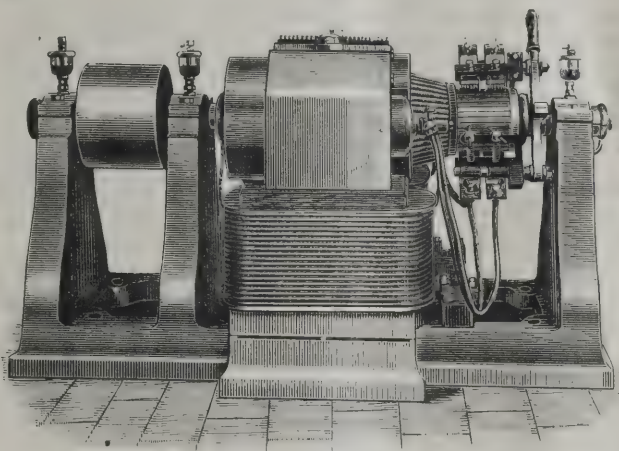
The motors are of the Elwell-Parker type, double limb, series wound, and run with 140 revolutions, but a velocity of 700 revolutions per minute is required to maintain a speed of eight miles per hour. There is only one motor to each car, carried on one of the bogie trucks by means of an aluminium, brass, or steel frame, which has three points of support, two being rigidly fixed on one axle of the bogie, and the other resting on the second axle, through the intervention of a strong helical spring. Thus it will be seen that the motor and its appendages are entirely independent of the oscillation of the car, due to variations of load. At one end of the armature are the commutator and brushes, and the other end carries a pinion, which gears right and left into two spur wheels carried by countershafts on a brass frame. On these same countershafts are fixed additional pinions, which gear into spur wheels on the two axles of the bogie, and thus the motion of the armature is gradually reduced to the speed required for the car, the proportion being about  $6\frac{1}{2}$  to 1. All the gearing is done by helical teeth.

The switch, by means of which the driver controls the current, and therefore the car, is placed on the car platform just beneath the steps, and is quite out of the way of the passengers. The lead, &c., joining the cells up to the switch, are enclosed in a teak matchboard casing, the switch being placed on the top of the casing. The part of the car floor over the motor is removable. The cars are lighted by two 16-candle-power incandescent lamps—one at each end. A powerful brake is provided, which grips the whole of the eight wheels at the same time, and there is also an auxiliary brake attached.

### THE PREECE DYNAMO.

IN the Preece dynamo, to which we referred in a recent issue and of which we now give an illustration, the bed-plate and brackets are one complete casting. The plummer blocks are fitted with adjustable phosphor bronze bearings, and each bearing is fitted with a sight feed lubricator.

The magnet yoke, which is cast in one piece, is let into a recess in the bed-plate, and the pole pieces are separate castings bolted to the magnet yoke. The field coils are wound upon separate shells with zinc flanges, and are interchangeable for all machines of the same output. The armature is built up with charcoal iron discs insulated from each other with a specially prepared varnished paper, and are held in position on the shaft by two insulated bolts passing through the driving



end plates which are firmly keyed to the shaft. The armature core is ventilated internally by suitable divisions being left at every 2 inches between the plates. The armature is wound one layer deep, with 19/17 strand braided cable, and connected up to a 60-part commutator, there being one complete turn per commutator bar.

The armature on the pulley side is provided with a blower to send a current of air through the pole pieces and prevent an accumulation of dust; both ends of the armature are protected with brass shields fitted to the pole heads. The brushes are made of soft brass wire and their pressure upon the commutator is regulated by thumb screws.

At a speed of 800 revolutions per minute the E.M.F. is 110 volts, and the current at full load, 250 amperes, there being no sparking. The rise of temperature after 10 hours continuous run is said to be 40 degrees on the armature conductors, and the field coils 30 degrees Fah. above the temperature of the air.

**A Locomotive Telephone Signal.**—In order to show that the telephone may be adopted as a danger signal on railway lines, a locomotive telephone signal was recently tested by the Baltimore and Ohio Railroad Company on about three miles of its track. The apparatus consists of a single iron rod running between the rails, supported on insulators, and an electric gong connected with a battery carried on the locomotive. The connection between the gong and the iron rod is made by means of an insulated wire from the gong to a wire brush underneath the locomotive, which touches the rod. Two trains approaching each other on the same track will complete a circuit and warn each other by ringing the gong. The gongs on the two trial trains commenced ringing when they were about two miles apart; the telephone mouthpiece was then switched to the wire, and conversation was carried on between the two drivers. The apparatus is stated to have worked very satisfactorily.

## LONDON COUNTY COUNCIL AND OVERHEAD WIRES.

## OBJECTIONS OF LOCAL AUTHORITIES.

ON Tuesday last, at the weekly meeting of the London County Council at Spring Gardens—Mr. Alderman HAGGIS in the chair—Mr. NATHAN MOSS, the Chairman of the Fire Brigade Committee, submitted a report containing the following statement:—

"We have to report with respect to the 200 additional fire-alarms authorised by the Council on 30th July last, that we have ascertained from the Post Office that the average annual cost of the call-points on the north side of the Thames will be about £9 12s. 8d. As this sum is less than the amount (£10) which we estimated, we have given directions for the work to be put in hand. As regards the additional fire-alarms south of the Thames, however, we have been informed by the Post Office that, in consequence of the objections of the local authorities of certain districts to the erection of overhead wires, underground pipes would have to be specially laid for the wires in such districts. The annual cost of the fire-alarms would, in consequence, be increased in some cases as much as four and five-fold. In fact, in one instance, at Tooting, a single call-point would cost more than £53 a year. We cannot recommend the Council to pay such a large sum for these fire-alarms, and we are accordingly unable at present to order the establishment of more than 20 out of the 52 which we proposed to have fixed in the part of London referred to. The average annual cost of these 20 will be £10 5s. 6d. each. The following are the stations which will not have their complement (10) of fire-alarms, viz.: Kennington, Tooting, Clapham, Battersea, Shooter's Hill, Blackheath, Lewisham, Camberwell and West Norwood. We may mention that we propose to have a fire-alarm fixed in Blackwall Lane, East Greenwich, the Vestry of Greenwich having asked that such a means of communication with the brigade might be afforded to the inhabitants of the locality."

Mr. BEACHCROFT wished to know whether it was the policy of the Fire Brigade Committee to encourage the erection of overhead wires?

Mr. MOSS stated that the matter referred to in their report was a rather serious one, so far as the committee were concerned. They felt that it was not desirable to incur the extra expense which would be necessary for the laying of underground pipes. Therefore, under the circumstances, they would have to forego placing some of the fire alarms, so long as the parochial authorities were so strongly opposed to overhead wires.

Mr. BEACHCROFT hoped the Council would not encourage the abominable example set in some cases of erecting overhead wires. (Hear, hear.) He hoped the committee would bring forward a special report on the subject.

## ANOTHER ELECTRIC LIGHTING BILL.

Mr. CHARLES HARRISON, as Chairman of the Parliamentary Committee, reported as under:—"We understand that another Electric Lighting Confirmation Bill is to be introduced, and that it will contain orders affecting the City of London. We were authorised on the 3rd June last to present a petition against any order which does not comply with the Council's resolutions of the 28th January and 22nd April, 1890, and we have authorised the preparation and presentation of petitions in the event of any of the orders complying with the above-mentioned resolutions."

## NOTES.

**Cardiff Lighting.**—At a recent meeting of the Lighting Committee, a deputation from the residents of Broadway attended, to ask for better lighting of that thoroughfare. It was stated that a great many shops now empty, would be occupied if Broadway were better lighted. The deputation were told that the matter would be favourably considered. The committee next received a deputation consisting of Mr. Garcke (secretary and manager), and Mr. Deakin (local manager), of the Brush Electric Lighting Company. Mr. Garcke dealt at length on the advantages of electric lighting, and urged the committee to recommend to the corporation that they support the application of the company next session of Parliament for a provisional order to illuminate Cardiff with the electric light. The chairman said that so far as a promise or entering into any contract, the committee were not in a position to take action. The deputation then withdrew. A motion that a special meeting be called to consider the matter, and that in the meantime the Town Clerk be instructed to ascertain if any corporate bodies had obtained provisional orders, and had granted them to electric lighting companies, and if so, upon what terms; also that the engineer procure particulars as to subways in use in other towns, the laying of subways in Cardiff, and other details.

**Electric Lighting in Newcastle.**—It has been resolved by the Lighting Committee of the Newcastle Corporation, to recommend the Watch Committee to light the whole of Neville Street with five electric arc lamps, in place of 80 or 90 gas lamps.

**Electric Lighting in South East London.**—The Committee of the House of Commons has passed a Bill confirming a provisional order granted by the Board of Trade to the Electric Installation and Maintenance Company for the electric lighting of the district surrounding the Crystal Palace. The area is defined to consist of a portion of the district of the Lewisham Board of Works, and small portions of Beckenham, Camberwell, Lambeth, and Croydon. The order granted to the Metropolitan Electric Supply Company for lighting the parish of Paddington was also confirmed.

**Electric Lighting at Mirfield.**—Messrs. Lister, of Battysford, Mirfield, contemplate having the whole of their works lit up by electricity. This is the sixth firm in Mirfield which has introduced electric lighting.

**Electric Lighting of St. Pancras.**—The electricity committee reported at the last vestry meeting that some 43 tenders had been received. The committee promises to report thereon at the earliest possible date. The London Electric Supply Corporation and the Metropolitan Electric Supply Company are again making applications for provisional orders to supply St. Pancras.

**Barnsley and the Electric Light.**—Considerable discussion is taking place in the Barnsley Town Council with respect to Mr. Bromley Holmes's advice that the Westinghouse Electric Company's tender be accepted at a cost of £17,800. The *Barnsley Independent* takes up the subject warmly, and wants to know why the tender of an English company, the National Electric Supply Company, for £11,888, should not be accepted. It concludes its article as follows:—"We also think they ought to give the work to English firms, in preference to giving it to firms which are not English. The question is a wide and an intricate one; but, on the face of it, this passing over of an English tender for an American tender which is *dearer*, will require considerable explanation, we think, before it can be rendered acceptable to the ratepayers. Seeing that the idea of introducing the electric light into the borough took its rise from the desire to get an illuminant cheaper than that supplied by the Barnsley Gas Company, the policy proposed by the Town Council may surely with reason be spoken of as economy extraordinary."

**Lighting the Portman Rooms.**—Messrs. Benham and Sons inform us that they have secured the contract for electrically lighting the Portman Rooms (formerly Madame Tussaud's exhibition. The Metropolitan Electric Supply Company is arranging a special main from the Manchester Square station.

**Electric Light in Edinburgh.**—At a sub-committee of the Lord Provost's Committee of the Town Council had under discussion last Friday the question of an electric supply for the city. Some conversation took place, and it was resolved that the Parliamentary solicitor should be instructed to report upon the position of the corporation in the matter.

**Robbery of Platinum.**—At the London Sessions, July 17th, four men, named Jeffries, Hewlett, Fenn, and Price, were brought up for judgment, having been convicted at the last sessions of stealing a large quantity of platinum, valued at between £800 and £900, the property of the Brush Electric Light Company, of Belvedere Road, Lambeth. Jeffries was sentenced to five years' penal servitude, following on previous convictions; Hewlett to sixteen, Fenn to ten, and Price to seven months respectively. The police engaged in the case were specially commended for their conduct.

**Electric Traction at Birmingham.**—The official inspection of the electric tramway on the Bristol Road by the Board of Trade has been made by Major-General Hutchinson, who was accompanied by Major Cardew, inspecting officer of the Electrical Department of the Board of Trade. The inspecting officer proceeded to Navigation Street, where he boarded one of the electric cars. The journey to Bournbrook, a little over three miles in length, was satisfactorily accomplished. The car ran rapidly to the Bristol Road, and Major-General Hutchinson, who was riding with the driver, suddenly gave the order on one of the inclines to stop the car. This was done to test the brake, and from the moment the brake was applied the car barely moved a length. Major-General Hutchinson was hardly satisfied with this. In his opinion the brake should have acted with greater effect, and the car should have stopped much more quickly. On reaching the dépôt at Bournbrook the Major-General inspected the engines, the electrical machinery, the elevators, and the cars. Shortly after 2 o'clock the return journey was commenced. On the decline from Wellington Road to Belgrave Road the car was suddenly stopped, but the distance run after the application of the brake was again greater than the inspecting officer approved. When the car rounded the curve from Suffolk Street to Navigation Street the speed was increased, and the vehicle proceeded down the street at a tremendous pace. Suddenly the brake was applied and the car was once more stopped within a length. The inspecting officer was still dissatisfied. He considered the car should have been pulled up much quicker, and he had the brake tested two or three times. The inspecting officer suggested two or three alterations for the purpose of improving the efficiency of the brakes, and these Mr. Joseph Smith promised should be carried out. The inspection, which in every other respect had been very satisfactory, then terminated.

**The Western Union Cables.**—Mr. G. von Chauvin writes:—There appears to be an impression that the fire at the Western Union building in New York has interfered with the despatch of cable messages over my company's Atlantic cables. As both the Atlantic cables of my company run direct into a special office—16, Broad Street, a considerable distance from the Western Union building—no delay has arisen to our Atlantic cable traffic.

**The Dire Effects of Magnetism.**—The writer of "Table Talk" in the Birmingham *Daily Mail* had some funny things to say on Saturday last respecting the Bristol Road Electric Tramway. After assuring his readers that the electric tram dépôt at Bournbrook is a much more interesting place to visit than one might suppose, he gives this piece of advice to anyone who is about to go there—leave your watch at home. During the several inspections that have taken place recently, several gentlemen have afterwards found that their watches persistently refused to go. Curiously enough, however, whilst some had this experience others have discovered no unfavourable effect upon their "tickers." Hereupon it seems that the newspaper man sought the reason, and he relates how one of the electricians told him that this was attributable to the fact that different individuals are very differently affected by electric influence. One person, said his informant, will much more readily transmit electricity than another. He goes on:—"There is an impression which I have frequently heard expressed that passengers by the electric cars will be liable to the same sort of thing; but I am assured that this cannot be so, as the force is not generated, but merely stored in the lower part of the cars, and is completely insulated."

**Channel Telephone Cable.**—It was stated last week that experiments are being made with a view to laying a telephonic cable across the Channel. We are under the impression that tests over the existing cables have been going on for some considerable period.

**Got the Needle.**—A lady stated last week, in the columns of the *Times*, how she had been duped by a gentleman calling himself an electrician, who undertakes the removal of superfluous hairs by the agency of the electric needle. She paid a guinea and signed a cheque for £45 before operations commenced, and had not been home a week before all the hairs commenced growing again. These, she was coolly informed, were new ones, and she was impudently asked how much more money she was willing to pay. She suggests that probably an action at law would have ended in her favour, but that would have involved further expenditure, and this she did not care to incur. There are other so-called electrical curative appliances besides needles which we should like to see dealt with in the same manner in the columns of the daily Press, and perhaps we may take the above publication as a good omen.

**A Telegraph Office Destroyed.**—An explosion took place at the Western Union Telegraph Company's offices, Broadway, New York, at seven o'clock on the morning of the 18th inst., in the battery room on the sixth floor, and the flames, which immediately broke out, soon spread to the portion of the building above, including the operating room and the offices of the Associated Press, both of which were gutted, while the lower floors were drenched with water. The loss is estimated at 250,000 dollars. Only about forty operators were on duty at the time, and all succeeded in effecting their escape.

**Railway Contracts.**—Woodhouse and Rawson United, Limited, have again secured the contract for the supply of electrical instruments on the London and North-Western Railway for the ensuing year. This contract has now been held by the firm for several years, whilst it has also been awarded the contract for the supply of instruments to the Caledonian Railway for the year.

**The American Eagle.**—The *Electrical Engineer* of New York has every reason to believe that Mr. Ferranti will emerge triumphantly from his arduous labours over the Deptford scheme; indeed, our contemporary thinks that there is now sufficient evidence to show that complete success will ultimately be attained. We sincerely rejoice to note that "the courage and enthusiasm which have thus far accompanied his work may possibly be traced to the touch of Yankee blood in his veins."

**Morgan's Electric Signal System.**—We are informed that the patent rights of this invention for the whole of Europe have been sold for £250,000. Operations in connection with the practical demonstration of the system in the Brixton district are now being carried on, and instead of 12 lamp-posts, as previously reported, it is proposed to erect 36.

**Promotion of New Companies.**—As many of the electrical companies which have recently been brought before the investing public have not been floated, the bringing out of several of the proposed new companies for dealing with electric traction, welding, lighting, &c., has, according to various authorities, been postponed for the present.

**Killed by Lightning.**—The artillery barracks at Comorn, Austro-Hungary, were recently struck by lightning. The electric fluid penetrated three rooms, and threw twelve men out of their beds. Two of the men were killed on the spot.

**Pneumatic Telegrams in Paris.**—A treaty securing for the Paris suburbs pneumatic telegrams in order to correspond with Paris has just been signed between the Director-General of Posts and Telegraphs, and M. Aigoin, director of the southern tramways, the author of the project.

**Submarine Navigation.**—A Madrid telegram of last Saturday says: "In view of the recent successful trials with Lieutenant Peral's electric submarine vessel, the Minister of Marine has appointed a Commission to report upon the advisability of the Government ordering the construction of several submarine torpedo boats."

**Electrical Enterprise in Saxony.**—A concession has been granted to a civil engineer and a firm of bankers in this city, authorising them to establish a network of cables for purposes of transmission of power and electric lighting direct from some coal mines through 168 towns in Saxony to Dresden.

**Hotel Métropole, Brighton.**—The electric light fittings for this hotel, which possess certain features of novelty, have been supplied by Messrs. Benham and Froude. The principal bed rooms are fitted with very pretty portable table pillars of four distinct types, the incandescent lamps burning within opal shades covered with silk and lace, of tints to harmonise with the decorations. In the private sitting rooms and important vestibules are electroliers in brass, richly chased and burnished, having from three to ten lights each, with tinted and cut shades and rope-like down rods. For the principal suite of three large public dining rooms, what may be termed "electric sunlights" have been adopted, several being fixed within a very few feet of the ceiling of each room. They comprise a large, handsome deep inverted brass disc, embossed and highly polished, within which are a number (varying from five to ten in one or two tiers) of glow lamps, the whole being surrounded by a heavy fringe of cut glass prisms, the glittering brass and the prismatic hues giving a most brilliant, sun-like effect. This arrangement was carried out in accordance with the ideas of the proprietors of the hotel.

**The St. Pancras Vestry.**—A curious specimen of the manners and customs of vestrymen came to light at a recent meeting of the St. Pancras Vestry, when it was proposed to fill a seat on the Electric Lighting Committee in the place of a retiring member. One of the two candidates was asked if it was true that he had issued cards to the committee, recommending a gentleman who wished to introduce a new scheme, and he explained that he had known the gentleman referred to for many years, and he was one of the most eminent electrical engineers in the metropolis. He had received an invitation from him to visit an installation at Paddington that had been in existence some four years, and to bring some friends with him, and he thought that it would be very interesting to the members of the committee to see an installation in good working order, and he accordingly invited some of them. Being further asked if it was true that at the last vestry meeting he introduced several members to this most eminent electrical engineer, he replied that the M.E.E.E. had certainly sent in his card and wished especially to be introduced to Mr. Westacott. If this was blandishment, it was utterly thrown away. Mr. Westacott hotly denounced the candidate's proceedings as a scandal, especially after the committee had already accepted the services of another eminent engineer. It was a curious fact, he said, that the M.E.E.E. knew all that had taken place in committee. The rival candidate, who, it was said, had been for ten years connected with electric lighting, was elected to the vacant seat.

**Coatbridge Lighting.**—Says the *Glasgow Herald*:—The decision given in the case of the Coatbridge Electric Lighting Provisional Order is of very considerable importance. It is the first case in which an electric lighting provisional order has been opposed by a gas company on the ground of competition, and as the gas company got the worst of it, it may be assumed that Parliament has set a precedent against such opposition for the future.

**Lavoisier's View.**—M. Berthelot, a member of the Académie Française, has written a book called "La Révolution de la Chimie Lavoisier," in which Lavoisier's incorrect but historically interesting opinion as to the nature of electricity is given as follows:—"I have thought for some time that the electric phenomena, like the phenomena of combustion, are merely the effect of decomposing air, and that electricity, consequently, is nothing but a very slow combustion."

**The Electric Sugar Fraud.**—The New York Courts have given judgment in favour of the English stockholders.

**Electricity and Water Power.**—The Sheffield Water Committee, in view of the probability of the Corporation obtaining power to supply electricity for public and private purposes in the borough, has called attention to the water power connected with their wheels on the Rivelin.

**Telegraphists and the State.**—The *Electrical Engineer* of New York points to England as proving that the lot of a "telegrapher," where the telegraphs are under Government control, is not one to be envied. Our contemporary has discovered a "rumour" that the Post Office contemplates sending to America for men, and observes that the few who might possibly go would hardly be likely to find America a pleasant country to return to.

**The Columbian Exhibition.**—An influentially-signed petition, the signatures of which include all the leading men and houses in Chicago, has been sent to the board of directors of the World's Columbian Exposition, requesting the appointment of Mr. J. P. Barrett, the City electrician of Chicago, as director of the electrical department of the exhibition. Mr. Barrett is a public official without commercial alliances, and his name has frequently figured in our pages.

**Telegraphs in South Africa.**—A correspondent writes to a contemporary that the Chartered South African Company's line of telegraphs has now been completed as far as Ramoutsa. The first message transmitted over the new line was one from the Chief Ikening to Sir Sydney Shippard, Administrator of British Bechuanaland. It was as follows:—"Congratulations on telegraph office being opened here. Hope it will lead to prosperity of my people. Am doing the best I can to get Mr. Stanford all the men he requires, and will help him in pushing forward with his work. It is a wonderful thing telegraphy. I am in the dark. I cannot understand it." The company is now laying the wire from Ramoutsa to Meschudi Lindewe's Town, which is to be the next station.

**Personal.**—Mr. Mark Bevan has commenced business at Cardiff as an electrical engineer and contractor. Mr. Bevan was, for several years, superintendent at Rio-de-Janeiro, for the Western and Brazilian Telegraph Company, and for 4½ years was in the service of Messrs. Siemens Brothers and Company at their works at Woolwich. On the recommendation of Messrs. Siemens Brothers he afterwards held the appointment of chief electrical engineer in the Torpedo Division of the Argentine Navy, and a similar appointment under the Chilean Government.

**Intended Electric Light on Borkum Island.**—The German Government has given notice that, during the summer of 1890, an electric light will be placed on Borkum Island, east side of River Ems entrance, about 1,200 yards southward of the principal lighthouse. It will be elevated 105 feet above high water, and should be visible in clear weather from a distance of 16 miles. During the summer of 1890, an electric light will be also placed near Campen, about four miles northward of Knock Lighthouse, east side of River Ems.

**The Houses of Parliament Lightning Rods.**—Messrs. R. Anderson & Co., the firm responsible for the lightning conductors on the Houses of Parliament, write respecting the recent fall of a piece of masonry, when Mr. Justice Grantham narrowly escaped. They state that examination has proved that the piece of stone had been cracked for some time before, and that the building was in no way damaged by lightning.

**Austin's Infant Dynamos.**—Mr. Austin informs us that he has secured Messrs. Paterson and Cooper as London agents for the sale of his dynamos and motors.

### NEW COMPANIES REGISTERED.

**Electricity Supply Companies Union, Limited.**—Capital, £100 in £1 shares. Objects: To form centres at which electrical energy may be generated and accumulated, and from which the same may be distributed for public and private lighting, for motive power or heat, for electro-plating, electro-deposition, telephonic, or other purposes. Signatories (with 1 share each): J. D. Pearson, 3, Oakleigh Road, New Southgate; W. A. Pittman, 7, St. Helen's Gardens, North Kensington; J. Aspinall, 34, Bowman's Buildings, Edgware Road; Wm. May and A. W. Bartlett, 18, Austin Friars; J. B. Rands, 5, Linnell Road, Camberwell; G. W. Schofield, 27, Austin Friars. Registered without special articles by Slaughter and May, 18, Austin Friars.

**Amalgamated Electricity Supply Companies, Limited.**—Capital, £100 in £5 shares. Objects and signatories as in preceding company. Registered 16th inst. by Slaughter and May, 18, Austin Friars.

**United Electricity Supply Companies, Limited.**—Capital, £100 in £5 shares. The objects and signatories are the same as in the two preceding companies. Registered 16th inst. by Slaughter and May, 18, Austin Friars.

**Woodward, Grosvenor and Company, Limited.**—Capital, £90,000 in £10 shares. Objects: To take over the businesses of Woodward, Grosvenor & Co., and the Stour Vale Mill Company, carried on at Kidderminster and 102, Newgate Street, and to trade as carpet manufacturers, spinners, general merchants, engineers, electricians, soap and glue manufacturers, &c. Signatories (with 1 share each): \*G. W. Grosvenor, Broome House, near Stourbridge; \*H. Mountford, Thurlow Park Road, West Dulwich; J. Mountford, M. Waite and R. Moule, Kidderminster; J. Lignton, Streatham Park; H. C. W. Mountford, West Dulwich. The first two signatories are appointed managing directors, each at a salary of £1,000 per annum. The company in general meeting will determine remuneration of ordinary directors. Registered 18th inst. by Emmett, Sons and Stubbs, 14, Bloomsbury Square.

**Franco-African Lighting Syndicate, Limited.**—Capital, £25,000 in £1 shares. Objects: To carry on in Algeria, Tunis, or other part of the French Dominions or Protectorates, the business of a gas or electric light company in all branches. Signatories (with 1 share each): E. G. Inman, 269, City Road; W. Cousens, 17, Victoria Street, S.W.; G. A. Stanbrough, 8, Hetherington Road, Clapham; T. W. Gardiner, 6, Heiron Street, S.E.; F. Burbidge, 44, Amwell Street, E.C.; E. Boucher, 229, High Street, Lewisham; E. G. Tanton, 11, Queen Victoria Street. Directors remuneration, £50 per annum each, and in addition 10 per cent. per annum on the net profits, the chairman to be entitled to double fees. Registered 19th inst. by Wm. Cousens, 17, Victoria Street, S.W.

**Earthy Metals Company, Limited.**—Capital £2,000 in £50 shares. Objects: To carry out an unregistered agreement with Luis Falero, M.F.S.T.E. To produce and prepare for market, sodium, potassium, magnesium, aluminium and other metals, and to carry on business as metallurgists, manufacturing chemists, and of makers of and dealers in electrical, chemical and scientific apparatus and materials. Signatories (with

1 share each): Major J. G. Scott, Winkfield, Berks; A. Codogan, 3, Sloane Gardens, S.W.; J. M. Maclean, M.P., 40, Nevera Square; J. W. Macfarlane, 2, Lexham Gardens; R. St. John Boddington, 15½, Parliament Street; H. M. Cadell, Bournemouth, N.B. Registered 19th inst., without special articles, by E. R. Crump, Solicitor, 15½, Parliament Street.

### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Windsor and Eton Electric Light Company, Limited.**—The registered office of this company is situated at 54, High Street, Windsor.

**Corinthian Electric Medical Battery Company, Limited.**—The annual return of this company, made up to the 30th June, was filed on the 15th inst. The nominal capital is £25,000 in £1 shares. 20,804 shares have been taken up, 20,000 of these being considered fully paid. Upon 804 shares the full amount has been called, the calls paid amounting to £800, and unpaid to £4. Registered office, 1, Gate Street, Lincoln's-Inn-Fields.

**Siemens Brothers & Co., Limited.**—The annual return of this company, made up to the 15th inst., was filed on the same day. The nominal capital is £500,000 in £100 shares, the whole of which are taken up. The sum of £85 has been called and paid upon each share, the paid up capital thus being £425,000.

**Mining and General Electric Lamp Company, Limited.**—The annual return of this company, made up to the 17th inst., was filed on the 19th instant. The nominal capital is £100,000 in £1 shares, 90,000 of which are taken up, 62,305 being considered fully paid. The full amount has been called and paid upon 27,695 shares.

### CITY NOTES, REPORTS, MEETINGS, &c.

#### The United River Plate Telephone Co., Limited.

In the absence of Lord Thurlow, Mr. J. Irving Courtenay, the deputy chairman, presided at the fourth annual ordinary general meeting of the shareholders, held at Winchester House on Tuesday last, to receive the report (printed in our last issue) and accounts for the year ending March 31st, 1890. About half a dozen shareholders were present.

The Chairman said the financial position in Buenos Ayres could not but be a cause of anxiety to all who were interested in the Argentine Republic. But from the best obtainable information—and the company was fortunate in numbering amongst its directors gentlemen who had passed the greater part of their lives in the River Plate—he believed that, with a prudent administration of its affairs, the country, with the aid of its great resources, would speedily overcome its present difficulties. The company's gross income for the year ending March 31st, 1890, amounted to £108,612 2s. 7d., as against £81,866 2s. 4d. for the previous twelve months. Those figures showed how largely the business had developed during the past year. There had been a considerable increase in working expenses, which was mainly caused by a large increase in wages and cost of material. Fortunately, there had been no serious question with the *employés*, but, as in the case of other River Plate companies, the depreciated currency had made the increase inevitable. There had also been some increase in taxation. These had caused an increase in the working expenses. A special item of expenditure was owing to the repairs rendered necessary by a cyclone in Rosario last December. The gravest loss, however, and that which was the cause of their reduced dividend, was that on exchange. It was one beyond the directors' control. It amounted to not less than £22,334 17s. 1d., as against £14,689 6s. 8d. in the previous year, or an increased loss of £7,645 10s. 5d. The total loss from this source was, therefore, about 8 per cent. on the company's paid-up capital. The result, after paying working expenses, debenture interest, and general charges, both in the River Plate and in London, was a profit of £34,198 6s. 5d., from which, after deducting the loss on exchange, viz., £22,334 17s. 1d., there remained a net profit of £11,863 9s. 4d., which, added to the balance from last year, viz., £1,210 7s. 2d., amounted to £1,373 16s. 6d. An interim dividend of 2 per cent., or £5,800, was paid in January last, and the directors recommended a further payment of 1 per cent. out of the balance. They proposed to carry forward £2,000 to the depreciation and renewal account, which would then stand at £9,000.

and they carried forward a balance of £2,373 16s. 6d. In view of the abnormal state of business in the Republic (which had continued for some time) the results obtained were fairly satisfactory, and he trusted the policy of the directors in carrying forward a substantial sum would be approved. There were some encouraging features in connection with their business in the Plate. On the 31st March, 1890, the date of the balance sheet, the number of their subscribers at Buenos Ayres was over 5,000. The company began business with about 3,000 subscribers. As might have been expected during such a crisis, a considerable number of people had taken out their telephones; but, on the other hand, each month had seen a steady influx of new subscribers, and, all things considered, the business of the company showed a most remarkable vitality. That was mainly owing to careful and vigilant administration both in Buenos Ayres and in Rosario. One of the company's representatives in Buenos Ayres wrote:—"We are giving a service such as we can safely say has never been given in Buenos Ayres before. Of course we have complaints, but they are brought down, we think, to a minimum and neutralised by the many expressions of satisfaction we hear on all sides." The shareholders would congratulate themselves upon having such painstaking and zealous representatives as Mr. Fells and Mr. Crabbe at Buenos Ayres and Mr. Chapple at Rosario. The directors had successfully carried out what was hinted in last year's report—i. e., they had raised the rates of subscription with a view to meet to some extent the increased expenditure and exceptional charges incident to the condition of currency in the Plate. The capital outlay for 1889-90 was £7,297 14s. 11d. less than in 1880-89, and that allowing for the outlay during that period for the purchase of the Rosario business. They had not lost sight of the construction of the Rosario trunk line, to be undertaken when a favourable opportunity presented itself. The issue of the 5 per cent. debenture stock and the conversion of 7 per cent. debentures had been satisfactorily carried out, and had evidently been appreciated by the shareholders. He was confident of the company's future. It was plain the business was steadily improving, and they might therefore expect at the end of the crisis to reap the fruits of the solid progress and the improved position they had attained in spite of the serious increase of financial obstacles they had and still encountered. Their receipts for the first quarter of the new year—that is, April to June—had exceeded those of any other quarter since the company started business. He moved the adoption of the report and accounts, and to declare a dividend of 1 per cent., or 1s. per share free of income tax (in addition to the interim dividend of 2 per cent. paid in January last), payable out of the remaining balance of £7,273 16s. 6d.—viz., £22,900.

Mr. Frank Jones seconded.

Mr. Peel, a shareholder, congratulated the directors upon the present position of the company. He, however, thought they might have imitated other companies and maintained its dividend. But that was a question of finance, and the directors might have acted discreetly under the circumstances.

Dr. Ellis asked whether the large increase of business was caused by the taking over by his company of the Rosario business. He also observed that last year the company paid 6 per cent. dividend, and had the rate of exchange remained the same, the company would be paying only 5 per cent. in the present year—that was to say, a difference of £7,000 in exchange would have meant 2 per cent. more than they actually received. He further said that the expenses caused by cyclones and that kind of thing ought to be met out of the depreciation and renewal fund. He also asked what had been the rate per cent. of the increase in subscribers from the 1st of January last. He felt sure the directors had done their very best, and that the feeling was shared by the other shareholders was manifest by the smallness of the meeting.

The Chairman replied that while it was true that the Rosario business had been taken into account, apart from that there had been a considerable increase in the Buenos Ayres business. He did not think it advisable to give precise figures of the increase in new subscribers. The increase in the rates of subscription had by no means had the prejudicial effect which some persons anticipated. In circumstances like depreciation of currency there was always increase in the cost of material, and that had seriously told upon the company. While he promised to take note of the observation with regard to charging damage from cyclones to the depreciation and renewal account, he thought they ought to have a strong reserve. This was essentially a time for a cautious policy.

Lord Thurlow and Mr. Fredk. Green were re-elected directors, Messrs. Cooper Bros. & Co. were reappointed auditors, and, with a vote of thanks to the board, the proceedings terminated.

### Crompton and Company, Limited.

THE second annual general meeting of the shareholders was held at the Cannon Street Hotel, on the 21st inst., when the report for the year ending 31st March, 1890 (printed in our last issue), with the accounts, was laid before the meeting.

The Chairman, Mr. R. E. B. Crompton, briefly alluded to the loss the company sustained by the death of Viscount Torrington. That loss was extreme. The deceased had taken an exceedingly keen interest in the company's affairs. When they last met some 1,200 of the preference shares had not yet been placed, but were allotted immediately afterwards. The directors then, in accordance with the terms of the prospectus,

applied to the Stock Exchange for a settlement and quotation for the preference shares. These had since been accorded. There had not been many sales in the past year, the apparent explanation being that members did not wish to part with what they believed to be a good dividend paying property. The company's business had increased very largely, and the directors had consequently been compelled to add to the plant at Chelmsford and elsewhere, and to increase the working capital, to do which they had exercised their borrowing powers, and had issued 5 per cent. debentures to the amount of £50,000, which was secured by a deed of mortgage. The whole of the £25,000 of debentures, originally offered, had been applied for, and the directors now proposed to offer the remaining £25,000 for subscription, and a circular would be sent out accordingly. The sum of £6,750, which last year appeared on the balance-sheet as a loan on mortgage of the Chelmsford works, had been paid off, and the debenture debt remained the only charge on the property. The profit for the year was £10,610 1s. 7d., or £2,000 more than the year before, and about £4,000 more than the average of the six years which preceded the formation of the company; a result which might be considered fairly satisfactory. After payment of the interim dividend in December last year, and providing for debenture interest and other charges, and after carrying the sum of £500 to the doubtful debts and contingencies account, there remained a balance of £6,030 6s. available for dividend, and out of this the directors proposed to pay 7 per cent. per annum for the half-year to the preference shareholders, and 5 per cent. upon the ordinary shares, carrying the balance, £474 18s. 10d., forward to the next year. The company's increasing business had necessitated capital expenditure for extension of premises and additions to plant. They had also taken over the portion of the company's Chelmsford property, which was leased to Crompton and Fawkes, and which adjoined the Arc works, and these were immediately available for the extension of the Arc works. During the past year the company had the good fortune to secure very large orders from three most important supply companies—viz., the Westminster, the Kensington, and the Notting Hill, for the fixing of machinery, and the supply and fixing of a complete system of underground mains, extending 40 or 50 miles through the London streets. In the early part of the year they worked with a separate staff taken from the temporary premises of the company's Kensington Court estate. These temporary premises, being no longer available, the directors had thought it advisable to lease the convenient premises, No. 1, Lillie Road, West Brompton, which were being fitted up, and were now the head-quarters of the company's engineering staff in connection with those large West End orders. The principal feature of those orders was that they seemed to offer a fair chance of a good profit, while the risks were not great. As regards other prospects, the company's order books were full for its own special type of large dynamo machines, switchboards, and that class of plant, and the general prospects of orders were better than he, the speaker, had ever known them to be since he entered the electrical business. They might congratulate themselves on the extremely good feeling prevailing between the staff and the workmen. They had succeeded in organising piecework on a more considerable scale than had yet been attempted, without encountering the difficulties which other engineering firms had met with. That was a great deal due to the tact and good management of the Chelmsford managers. The very delicate question of piecework had been the bone of contention which had caused so many strikes all over the country. In the company's case it was a great step in advance, as it enabled it to keep accounts and to know the cost of its work with much greater accuracy than was possible when the bulk of the work was done by day labour. Regarding the accounts, they called for no special remark from him. He therefore moved the adoption of the report and accounts.

The Secretary, in reply to a shareholder, explained that the accounts of the Australian Company were not yet to hand; one of the managers of that company was bringing them over. In the meanwhile they were said to show a very satisfactory profit. The motion was seconded and carried unanimously.

The Chairman moved to declare a dividend at the rate of 7 per cent. per annum for the half year, payable on the company's preference shares, and a further dividend of 5 per cent. per annum upon the ordinary shares. The motions were seconded and carried unanimously.

The Chairman, in moving the re-election of Sir Charles Grant, K.C.S.I., as a director, spoke in warm terms of the services of that gentleman, who became chairman of the company on the death of Lord Torrington. If he, Mr. Crompton, occupied that position to-day, it was because from his intimate connection with the business, he was the best fitted to answer questions. But Sir Charles Grant had been a very powerful and steadfast member of the board, and one whose loss, if he left it, would be greatly felt. The motion was seconded and carried unanimously.

The Chairman, replying to a vote of thanks to the board, said the sole business of his life was to look after the company's interests. The proceedings then terminated.

### The South of England Telephone Company, Limited.

THE seventh ordinary general meeting of the shareholders was held at Winchester House, on the 18th inst., at twelve, when the following report for the year ending 30th April, with a statement of accounts, was presented. The expenditure on capital account for the past year amounts to £14,116 2s. 10d., bringing the total of that account to £78,418 2s. The revenue account shows a sum

of £21,549 18s. 9d. for subscriptions and rentals, and a net credit balance of £6,148 5s. 4d., making, with the sum of £627 1s. 2d. brought forward from last year, an available balance of £6,775 6s. 6d. Of this amount the sum of £1,796 14s. 7d. has been absorbed by the payment of an interim dividend on the preference shares at the rate of 6 per cent. per annum for the half-year ending 30th October, 1889. In order to strengthen the position of the company, the directors have considered it advisable to carry £1,000 to the reserve fund; and they now recommend the payment of a final dividend at the rate of 6 per cent. on the preference shares (£2,096 6s. 2d.), for the half-year ending 30th April, 1890, and the payment of a dividend of  $\frac{1}{2}$  per cent. on the ordinary shares, free of income tax (£1,500), for the year, leaving a balance of £382 5s. 9d. to be carried forward. The completed trunk lines are as follows:—Brighton—Shoreham; Brighton—Eastbourne; Brighton—Worthing; Shoreham—Worthing; Brighton—Hurst; Brighton—Newhaven; Brighton—Rottingdean; Brighton—Lewes; Lewes—Eastbourne; Canterbury—Ramsgate; Ramsgate—Margate; Ramsgate—Sandwich; Ramsgate—Deal; Canterbury—Faversham; Canterbury—Whitstable; Canterbury—Dover; Dover—Folkestone; Chatham—Maidstone; Norwich—Great Yarmouth; Northampton—Wellingboro'; Wellingboro'—Kettering; Kettering—Rushden; Tunbridge Wells—Tonbridge.

The trunk lines in course of construction are Canterbury—Ashford; Faversham—Sittingbourne.

At the 30th April this year, 2,265 exchange lines and 583 private lines were completed, and 91 exchange lines and 19 private lines were in course of construction.

Telephone exchanges are now open at the following places:—Brighton, Cambridge, Canterbury, Chatham, Deal, Dover, Eastbourne, Faversham, Folkestone, Great Yarmouth, Hastings and St. Leonards, Hurst, Hythe, Ipswich, Kettering, King's Lynn, Lewes, Maidstone, Margate, Newhaven, Northampton, Norwich, Oxford, Peterborough, Ramsgate, Reading, Rottingdean, Rushden, Sandgate, Sandwich, Shoreham, Tunbridge Wells, Watford, Wellingborough, Whitstable, Worthing.

#### Comparative Statement of Exchange and Private Line Business.

	Exchange.	Private.
April 30th, 1886 ... ..	687	248
April 30th, 1887 ... ..	1,130	348
April 30th, 1888 ... ..	1,521	386
April 30th, 1889 ... ..	1,972	500
April 30th, 1890 ... ..	2,356	602

The Chairman (Mr. D. O. Bateson), explained why the report and balance sheet had been delayed. The company's licence from the Post Office was terminable at periods of seven years by six months' notice from the Postmaster-General; and that notice not having been given, the company had a fresh life of seven years. It was thought undesirable that the state of the company's affairs should be published so long as the matter of the licence was uncertain; but after the Postmaster's decision was known no time was lost in presenting a report and calling a meeting. The company's books were, in fact, balanced and its accounts ready for audit six months before the 30th April. The reason why the preference dividend was not paid at the beginning of May, as formerly, was that some of the shareholders doubted the correctness of the former practice. They said that while it was perfectly right to pay an interim dividend on the estimate of profits, it was scarcely business-like to make the final distribution before ascertaining the correct balance. The directors had adopted that view, and propose to continue it in practice. There was no reason to complain of the progress of the company's business. The increase was not very rapid, but it was continuous and steady, considering the somewhat bad pasture. He was sorry the National Telephone Company apparently could not see its way to admitting the company to its system, as the company was thereby debarred from exploiting the most valuable part of its district, namely, that within the 20 miles radius of London. There were many residents and business firms most anxious for this means of communication, which, he thought, could not long be delayed, as it would be extremely profitable to the telephone companies. The trunk line system in East Kent would shortly be completed by the opening of a route between Ashford and Canterbury, which would place the former town in communication with nearly all the business centres and seaside towns in the district. They were indebted to Lord Winchelsea for the grant of wayleaves through Eastwell Park. The cost of wayleaves was increasing, and though, as a rule, they were granted without much difficulty, the directors had occasionally to complain of being squeezed unmercifully. In such cases they preferred to alter the route, if possible, even at considerable extra expense. The rating question was becoming serious for telephone companies, and the question had been raised in many places. In Brighton, the board appealed to the Quarter Sessions against a heavy assessment in vain, and as the parent company would be no party to the expense of an appeal to the Queen's Bench, it had to be relinquished. As regards the accounts, the gross rentals had increased by £3,676; that was about the usual average. This year, however, the shareholders derived no benefit from the improvement, as the auditors stood out for carrying a much larger proportion of the wages and office expenses to revenue than was thought necessary last year. The reserve, it was thought, ought to be increased, as it had not been altered for some years; and, no doubt, the older the company grew, the expenditure necessary for repairs of lines, altering routes, &c., grew also. That, however, the directors provided for in the

balance sheet originally submitted; but the shareholders' auditor was resolved that the entire increase for the year should go for maintenance, although the working of the new lines was undoubtedly capital expenditure. The directors still thought so large a sum as £3,758 an unnecessary and inequitable addition to the maintenance fund, but as a clean certificate was refused, and they were threatened with a contentious meeting, they agreed to the inevitable, and left the matter to the shareholders. No doubt the alteration would strengthen the financial position of the company, and though probably the selling value of the ordinary shares would be temporarily lessened to a small extent, the value of the preference shares ought at least to be maintained, as they were a steady and reliable security. He moved the adoption of the report and accounts, and to declare a dividend at the rate of 6 per cent. per annum for the half-year ending April 30th, 1890, on the preference shares, payable the 19th inst., and a further dividend at the rate of  $\frac{1}{2}$  per cent. per annum, free of income tax on the ordinary shares, payable on the 19th.

The resolution was seconded by Mr. C. Billett, who, whilst regretting last year's 1 per cent., reminded them that the missing  $\frac{1}{2}$  per cent. would go to strengthen the company.

The motion was carried unanimously.

The Chairman, replying to a shareholder, as to negotiations between the company and the National Telephone Company, said that no such negotiations had ever taken place. The directors could do nothing without the shareholders' consent at a general meeting.

A shareholder strongly objected to anything like the company's shares being valued at 5s., as the National Telephone Company appeared to do by their report.

Mr. Bateson was re-elected to the Board, and Mr. J. Weise, the shareholders' auditor, was re-appointed.

With a vote of thanks to the Board, the meeting closed.

#### The Direct United States Cable Company, Limited.

THE report of the directors for the six months ended 30th June, 1890, to be presented at the twenty-sixth ordinary general meeting of the company, to be held at Winchester House, 50, Old Broad Street, in the City of London, on Friday, the 25th day of July, 1890, at 2 p.m., states:—The half-year's revenue (subject to revision on decision of the case mentioned below), after deducting out-payments, amounted to £40,017 1s. against £39,626 8s. 5d. (after similar deductions) for the corresponding period of 1889, being a difference of £390 12s. 7d. in favour of the half-year under review.

The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £17,616 5s. 8d., leaving a balance of £22,400 15s. 4d. as the net profit of the half-year, making, with £8,317 19s. 4d. brought forward from the previous half-year, a total of £30,718 14s. 8d. For the corresponding half-year of 1889 the working expenses and other payments amounted to £16,676 3s. 9d.

Three quarterly interim dividends of 3s. 6d. each per share, amounting to £31,872 15s., have been declared and paid during the financial year, and a final payment of 3s. 6d. per share is now proposed, making, with the three interim dividends, 3 $\frac{1}{2}$  per cent. for the year, being a total distribution of £42,497. An amount of £8,502 4s. 5d. has been transferred to the reserve fund account, which now stands at £250,000, and the balance of £968 0s. 3d. on the revenue account is proposed to be carried forward.

During the earlier portion of the past half-year the traffic showed a slight diminution as compared with the corresponding period of the previous year, but lately an increase has taken place which it is hoped may be progressive.

The Anglo-American Company having in January last opened offices of its own in New York, the expense of the office at 40, Broadway, in that city, previously maintained as a joint office, is now entirely borne by this company, accounting for the increase in the expenses during the past half-year. The maintenance of an independent office in New York is regarded as necessary.

A station has been opened by this company at 40, Hope Street, Glasgow. These additional facilities are already producing beneficial results.

A break occurred in the short section of cable on January 19th last, about 122 knots from Halifax, which was repaired on March 30th.

On April 10th a fault was removed from the shore end of the same cable near Rye Beach.

On May 26th a break occurred in the main cable which was promptly repaired on the 29th.

The breaks in the cables were found to have been caused by vessels' anchors.

The repairing operations have cost £4,919 13s. 5d., which has been debited to the reserve fund account as heretofore.

The interests of the company were represented at the International Telegraphic Conference recently held in Paris. In the case of the Anglo-American Telegraph Company v. Cie. Française du Télégraphe de Paris à New York, the appeal to the Council of State, mentioned in the report to the 30th June, 1889, is still pending. Pursuant to the provisions of the Articles of Association, two of the directors, viz., Charles Meara, Esq., and E. M. Underdown, Esq., Q.C., retire by rotation, and being eligible, offer themselves for re-election.

Mr. John G. Griffiths, F.C.A., and Mr. John Sawyer, F.C.A., the auditors, retire pursuant to the Articles of Association, and offer themselves for re-election.

**The Westinghouse Electric Company.**

At a meeting of the stockholders of the Westinghouse Electric Company on July 8th, at the offices of the company in the Westinghouse Building, Pittsburgh, Pa., Mr. George Westinghouse, jun., made a statement to the meeting, in which the following occurs:—The board of directors are of opinion that a total increase in the capital stock of not less than \$5,000,000 should now be authorised in order to provide for the future requirements of the company. It is proposed to issue forthwith to each stockholder of record on this date an assignable right to subscribe, on or before August 1st, 1890, for one half share of stock for each share now standing in his name on the books of the company, at \$40 per share, this price being determined by a distribution or an allowance from the surplus earnings. Of this price one-quarter will be payable on August 1st, one-quarter September 1st, one-quarter October 1st, and one-quarter November 1st. Mr. Geo. Westinghouse, jun., has agreed to take \$1,250,000 of stock on the terms above indicated. If each of the other stockholders will subscribe to the number of shares to which he is entitled, the company will be enabled to provide for a large increase in its business. The board believe it to be to the pecuniary interest of each stockholder to subscribe for his amount of stock, and thereby aid in increasing the earning capacity of the company, which will have the immediate effect of enhancing the value of the shares already outstanding, and of the shares which in this manner will be secured at a reduced rate. The board believed that great profit would accrue to the company by securing foreign patents on the more important of the inventions exploited by it in this country. This policy resulted in an order from the Metropolitan Electric Supply Company, Limited, of London, for a central station of 10,000 lights capacity, which has since been increased to 25,000. The station is now in operation with entire satisfaction, and is the most complete and perfect central station in Europe. A company known as the Westinghouse Electric Company, Limited, has been organised in London, to operate these patents, and this company has received in payment for the patents and the money expended in the development of that business £301,000 of the stock of that company, which is the controlling interest. The English company has recently received orders for other plants, and is in negotiations for others of a very extensive character, with every prospect of success. Indeed, the business abroad bids fair to reach proportions that will equal, if not be greater, than those of the parent company, and to be a source of great profit to it. The majority of the board of the Westinghouse Electric Company, Limited, are also members of the Westinghouse Brake Company, Limited, of London, and the business is being conducted on the same lines which rendered the latter company so successful. Its operations are under the supervision and direction of Mr. H. M. Byllesby, the vice president of this company, who is its managing director, and is now in England giving it his personal attention.

**The Mutual Telephone Company, Limited.**

A MEETING of the shareholders of the Mutual Telephone Company Limited, was held on Monday in the Memorial Hall, Albert Square, Mr. A. D. Provand, M.P., in the chair.

Mr. Provand said the first resolution was that the capital of the company be increased to £350,000. The company was registered with £100,000 capital, which was sufficient for Manchester and Liverpool, but they had had so much encouragement in Glasgow—where more than 1,000 firms have signed the preliminary circulars—and also in other places, that they now asked for the capital to be increased sufficiently to allow them to commence operations in other cities. None of this capital was to be asked for in Manchester. They required £45,000 to erect their exchange; more than £40,000 of this had been allotted, and applications were steadily coming in. They had therefore all that was required for Manchester. The second resolution to alter the articles of association, so as to permit them to pay interest up to 10 per cent., instead of being limited to 6 per cent. This alteration was asked for because they had found it difficult to create a company on strictly mutual terms—that was to say, every renter of the company's telephones being a holder of shares in the company. As all the renters were not shareholders, some of them must take an increased number of shares to make up for those who took none, and it appeared 6 per cent. was not a sufficient inducement for these shares to be taken up, nor was it a sufficiently high rate of interest to promise to pay on the business. This would not add much to the working expenses. In their estimate of earnings they put down the 2,500 wires of the Manchester exchange at £5 each, which was the rate to shareholders, but probably 1,500 or 1,600 of their wires would be rented by non-shareholders, who would pay the higher rate of £6. This would add, say, £1,500 or £1,600 to their earnings, and if they paid the full 10 per cent. interest on the 4,500 shares held in Manchester, it would amount to only £1,800 extra interest, which would be almost met by the extra rates for the telephones rented by non-shareholders. They had in Manchester about 650 shareholders, and when all their wires were applied for, they expected the number would be 900, perhaps even 1,000, holding 4,500 shares; and as the strength of the company largely depended on the number of shareholders, everything should be done to increase that number. The resolutions were put to the meeting and carried.

**The Edison and Swan United Electric Light Company.**

THE directors' report and the accounts for the year ending 30th June, 1890, states the business of the company has resulted in a credit balance of £61,115 3s. 3d. Of this amount £12,371 14s. 7d. has been absorbed by the payment of an interim dividend on the A shares, at the rate of 7 per cent. per annum, for the first six months of the year. The directors recommend the payment of the following dividends on the A shares, free of income tax, and to be distributed in accordance with Clause 87 of the Articles of Association:—

(a.) At the rate of 7 per cent. per annum for the half-year ending 30th June, 1890 (making 7 per cent. for the year):

(b.) Four per cent. in completion of payment of arrears of cumulative preference dividend for the year ending 30th June, June, 1884:

(c.) Four per cent. in respect of arrears of cumulative preference dividend for the year ending 30th June, 1885:

which will absorb £40,649 19s. 3d.; leaving £8,093 9s. 5d., which the directors have carried to the reserve fund, in accordance with Article 89 of Articles of Association. The directors have been adding to the buildings and plant at the factory so as to enable them to manufacture lamps in sufficient numbers to meet the demand which will arise as the supply companies extend their operations in London and other towns. Mr. Shelford Bidwell, F.R.S., retires from the board, and offers himself for re-election as a director. The auditors, Messrs. Welton, Jones and Co. retire, and are eligible for re-election.

**The Manchester Edison-Swan Company, Limited.**

In their report for the year ending May 31st, 1890, to be submitted with the accompanying balance-sheet at the meeting of shareholders on the 28th inst., at the Albert Memorial Hall, Manchester, the directors state the net profit, including last year's balance, as £1,647 6s., which they propose to appropriate as follows:—£1,000 to payment of dividend at 5 per cent per annum, and £647 6s. to balance carried forward. It is proposed to issue the dividend warrants on August 1st, 1890. Mr. W. P. James Fawcus has been appointed managing director, vice Mr. J. R. Williams resigned through ill-health. The retiring directors, Sir Jos. C. Lee and Mr. J. C. Waterhouse, offer themselves for re-election.

**The Wendigo Copper Company, Limited.**—This company was advertised this week with a capital of £225,000. Of this a first issue of 12,500 shares of £5 each is offered to the public, and a like number of shares will be taken by the vendors in part payment of purchase money. The object of the company is to purchase a large tract of land situate on Isle Royale, Lake Superior, Michigan, U.S.A., amounting in all to about 5,120 acres, and to prosecute mining and the development of its mineral and other resources, which are said to be extensive. The copper is in its pure metallic state, and is termed "native," and the methods of winning it and reducing it to cake and ingot copper are the simplest and cheapest. As the company will have its own harbour and docks on the property, the cost of the transit should be less than from many of the mines on the south shore.

**The Eastern Extension Australasia and China Telegraph Company, Limited.**—The directors notify that the coupons on this company's 6 per cent. debentures, due on August 1st proximo, will be paid on and after that date at the Consolidated Bank, 52, Threadneedle Street, E.C. Coupons must be left three clear days for examination.

**The Cuba Submarine Telegraph Company, Limited.**—After placing £2,500 to the reserve fund, the directors recommend a dividend at the rate of 8 per cent. per annum for the half-year ended June 30th, leaving £501 to be carried forward.

**Anglo-American Telegraph, Limited.**—Interim dividend for the quarter: 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, payable on 1st August.

**The Eastern Extension Telegraph Company.**—It was notified early in the week that telegraphic communication with Australia, New Zealand, and Tasmania is now restored.

**The Chemical Carbon Company, Limited.**—It has been resolved to wind up the company, Messrs. A. Dowling and Thos. Purberry, of Basingstoke, to be liquidators.

**Elmore's Patent Copper Depositing Company, Limited.**—The transfer books will be closed till July 28th, inclusive, for the purpose of paying a dividend.

**TRAFFIC RECEIPTS**

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending July 18th, amounted to £4,174.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 15th July, are £2,879, as compared with £2,553 in the corresponding period of 1889.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 18th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,208.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued,	Name.	Stock or Share.	Closing Quotation. (July 17.)	Closing Quotation. (July 24.)	Business done during week ending July 24, 1890.	
					Highest.	Lowest.
£						
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	97 — 100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	50 — 51	50 <sup>3</sup> / <sub>8</sub>	50
2,725,420	Do. do. 6 p. c. Preferred	Stock	86 — 87	86 — 87	87 <sup>3</sup> / <sub>8</sub>	87
2,725,420	Do. do. Deferred	Stock	14 <sup>1</sup> / <sub>2</sub> — 14 <sup>3</sup> / <sub>2</sub>	14 — 14 <sup>1</sup> / <sub>2</sub>	14 <sup>3</sup> / <sub>8</sub>	14 <sup>1</sup> / <sub>16</sub>
130,000	Brazilian Submarine Telegraph, Limited	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12	12	11 <sup>3</sup> / <sub>4</sub>
99,000	Do. do. 5 p. c. Bonds	100	102 — 104	102 — 104		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1 <sup>3</sup> / <sub>4</sub> — 2	1 <sup>3</sup> / <sub>4</sub> — 2		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1 <sup>3</sup> / <sub>8</sub> — 1 <sup>7</sup> / <sub>8</sub>	1 <sup>3</sup> / <sub>8</sub> — 1 <sup>7</sup> / <sub>8</sub>		
\$7,216,000	Commercial Cable, Capital Stock	\$100	103 — 105	103 — 105	103 <sup>1</sup> / <sub>8</sub>	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	<sup>3</sup> / <sub>4</sub> — <sup>1</sup> / <sub>2</sub>	<sup>9</sup> / <sub>16</sub> — <sup>1</sup> / <sub>16</sub>	<sup>1</sup> / <sub>8</sub>	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>		
16,000	Cuba Telegraph, Limited	10	12 <sup>3</sup> / <sub>4</sub> — 13 <sup>1</sup> / <sub>4</sub>	12 <sup>3</sup> / <sub>4</sub> — 13 <sup>1</sup> / <sub>4</sub>	13 <sup>1</sup> / <sub>4</sub>	12 <sup>3</sup> / <sub>4</sub>
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited	5	3 <sup>1</sup> / <sub>4</sub> — 3 <sup>3</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>4</sub> — 4		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9 <sup>3</sup> / <sub>4</sub>	...
60,710	Direct United States Cable, Limited, 1877	20	10 <sup>1</sup> / <sub>2</sub> — 10 <sup>3</sup> / <sub>4</sub>	10 <sup>1</sup> / <sub>2</sub> — 10 <sup>3</sup> / <sub>4</sub>	10 <sup>1</sup> / <sub>2</sub>	10 <sup>3</sup> / <sub>16</sub>
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14 <sup>1</sup> / <sub>2</sub>	14 — 14 <sup>1</sup> / <sub>2</sub>	14 <sup>5</sup> / <sub>16</sub>	14 <sup>1</sup> / <sub>16</sub>
70,000	Do. do. 6 p. c. Preference	10	15 — 15 <sup>1</sup> / <sub>2</sub>	15 — 15 <sup>1</sup> / <sub>2</sub>	15 <sup>1</sup> / <sub>2</sub>	15 <sup>1</sup> / <sub>16</sub>
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 — 111	108 — 111	108 <sup>1</sup> / <sub>4</sub>	...
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109		
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13 <sup>3</sup> / <sub>8</sub> — 14 <sup>1</sup> / <sub>2</sub> xd	14 — 14 <sup>1</sup> / <sub>2</sub> xd	14 <sup>3</sup> / <sub>16</sub>	14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	101 — 103	101 — 103		
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106	103 — 106		
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	103 — 106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	100 — 103	100 — 103		
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>4</sub>		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 <sup>1</sup> / <sub>2</sub> — 6 <sup>1</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub> — 6	5 <sup>1</sup> / <sub>2</sub>	5 <sup>5</sup> / <sub>16</sub>
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	5	2 — 2 <sup>1</sup> / <sub>2</sub>	2 — 2 <sup>1</sup> / <sub>2</sub>		
180,227	Globe Telegraph and Trust, Limited	10	9 <sup>1</sup> / <sub>2</sub> — 9 <sup>3</sup> / <sub>4</sub>	9 <sup>1</sup> / <sub>2</sub> — 9 <sup>3</sup> / <sub>4</sub>	9 <sup>3</sup> / <sub>8</sub>	9 <sup>1</sup> / <sub>16</sub>
180,042	Do. do. 6 p. c. Preference	10	15 <sup>1</sup> / <sub>2</sub> — 15 <sup>3</sup> / <sub>4</sub>	15 <sup>1</sup> / <sub>2</sub> — 15 <sup>3</sup> / <sub>4</sub>		
150,000	Great Northern Tel. Company of Copenhagen	10	15 <sup>3</sup> / <sub>4</sub> — 16 <sup>1</sup> / <sub>2</sub> xd	15 <sup>3</sup> / <sub>4</sub> — 16 <sup>1</sup> / <sub>2</sub>	16 <sup>1</sup> / <sub>8</sub>	15 <sup>3</sup> / <sub>4</sub>
40,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103	100 — 103	101 <sup>1</sup> / <sub>2</sub>	...
250,000	Do. do. do. (issue of 1883)	100	105 — 108	105 — 108		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	12 — 13	12 — 13		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 <sup>1</sup> / <sub>2</sub> — 19 <sup>1</sup> / <sub>2</sub> xd	18 <sup>1</sup> / <sub>2</sub> — 19 <sup>1</sup> / <sub>2</sub> xd	18 <sup>1</sup> / <sub>4</sub>	...
200,000	Do. do. 4 <sup>1</sup> / <sub>2</sub> p. c. Deb., 1896	100	103 — 105	103 — 105		
17,000	Indo-European Telegraph, Limited	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures	100	107 — 110	107 — 110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>		
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 — 5 <sup>1</sup> / <sub>2</sub> xd	5 <sup>1</sup> / <sub>16</sub>	5
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 <sup>1</sup> / <sub>2</sub> — 12 <sup>3</sup> / <sub>4</sub>	12 — 12 <sup>1</sup> / <sub>2</sub> xd	12 <sup>1</sup> / <sub>16</sub>	12 <sup>9</sup> / <sub>16</sub>
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 <sup>1</sup> / <sub>2</sub> — 10 <sup>3</sup> / <sub>4</sub>	10 <sup>1</sup> / <sub>2</sub> — 10 <sup>3</sup> / <sub>4</sub> xd		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	<sup>1</sup> / <sub>4</sub> — <sup>3</sup> / <sub>8</sub>	<sup>1</sup> / <sub>4</sub> — <sup>3</sup> / <sub>8</sub>		
9,000	Reuter's, Limited	8	7 <sup>3</sup> / <sub>4</sub> — 8 <sup>1</sup> / <sub>4</sub>	7 <sup>3</sup> / <sub>4</sub> — 8 <sup>1</sup> / <sub>4</sub>	8 <sup>1</sup> / <sub>4</sub>	...
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	{ 1	{ <sup>1</sup> / <sub>4</sub> — ...	{ <sup>1</sup> / <sub>4</sub> — ...		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	2 <sup>3</sup> / <sub>4</sub> — 3 <sup>1</sup> / <sub>4</sub>	2 <sup>3</sup> / <sub>4</sub> — 3 <sup>1</sup> / <sub>4</sub>		
3,381	Submarine Cables Trust	Cert.	112 — 116	112 — 116		
78,949	Swan United Electric Light, Limited (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	5 — 5 <sup>1</sup> / <sub>2</sub>	5 — 5 <sup>1</sup> / <sub>2</sub>	5 <sup>3</sup> / <sub>8</sub>	5 <sup>1</sup> / <sub>4</sub>
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45 xd	43 — 45 xd	44	42 <sup>1</sup> / <sub>2</sub>
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
55,000	United River Plate Telephone, Limited	5	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 — 4 <sup>1</sup> / <sub>2</sub>		
146,000	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94		
100,000	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10 xc	9 — 10 xd		
300,000	Do. do. do. 5 p. c. Debentures	100	99 — 102	99 — 102	100 <sup>3</sup> / <sub>4</sub>	...
30,000	West Coast of America Telegraph, Limited	10	6 — 6 <sup>1</sup> / <sub>2</sub>	5 <sup>1</sup> / <sub>2</sub> — 6 <sup>1</sup> / <sub>4</sub>	5 <sup>3</sup> / <sub>8</sub>	...
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	106 — 110	106 — 110	108 <sup>1</sup> / <sub>2</sub>	...
64,572	Western and Brazilian Telegraph, Limited	15	10 — 10 <sup>1</sup> / <sub>2</sub>	10 <sup>1</sup> / <sub>2</sub> — 10 <sup>3</sup> / <sub>4</sub>	10 <sup>5</sup> / <sub>16</sub>	10 <sup>1</sup> / <sub>8</sub>
26,986	Do. do. do. 5 p. c. Cum. Preferred	7 <sup>1</sup> / <sub>2</sub>	6 <sup>1</sup> / <sub>2</sub> — 7	6 <sup>1</sup> / <sub>2</sub> — 7	6 <sup>1</sup> / <sub>16</sub>	...
26,986	Do. do. do. 5 p. c. Deferred	7 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>4</sub> — 4 <sup>1</sup> / <sub>4</sub>	3 <sup>3</sup> / <sub>4</sub> — 4 <sup>1</sup> / <sub>4</sub>	4	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	106 — 109	106 — 109	107 <sup>1</sup> / <sub>2</sub>	...
250,000	Do. do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 — 107	104 — 107		
88,321	West India and Panama Telegraph, Limited	10	2 <sup>3</sup> / <sub>8</sub> — 2 <sup>5</sup> / <sub>8</sub>	2 <sup>3</sup> / <sub>8</sub> — 2 <sup>5</sup> / <sub>8</sub>	2 <sup>5</sup> / <sub>8</sub>	2 <sup>1</sup> / <sub>4</sub>
34,563	Do. do. do. 6 p. c. 1st Preference	10	11 — 11 <sup>1</sup> / <sub>2</sub>	11 — 11 <sup>1</sup> / <sub>2</sub>	11 <sup>3</sup> / <sub>8</sub>	11 <sup>1</sup> / <sub>4</sub>
4,669	Do. do. do. 6 p. c. 2nd Preference	10	12 <sup>1</sup> / <sub>2</sub> — 13 <sup>1</sup> / <sub>2</sub>	12 <sup>1</sup> / <sub>2</sub> — 13 <sup>1</sup> / <sub>2</sub>		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
179,300	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 101	99 — 101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1 <sup>1</sup> / <sub>4</sub> — 1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>4</sub> — 1 <sup>3</sup> / <sub>4</sub>		

\* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6<sup>1</sup>/<sub>2</sub> paid), 7<sup>1</sup>/<sub>2</sub>—7<sup>3</sup>/<sub>4</sub>.—Electric Construction Corporation (£10 paid), 7<sup>3</sup>/<sub>4</sub>—8<sup>1</sup>/<sub>4</sub>.  
Elmore Copper Depositing Priorities, 6<sup>1</sup>/<sub>2</sub>.—Elmore Wire, <sup>1</sup>/<sub>4</sub> dis—par.—House-to-House Company (£5 paid), 5 — 5<sup>1</sup>/<sub>2</sub>.—London  
Electric Supply Corporation, Ordinary (£5 paid), 1<sup>1</sup>/<sub>2</sub>—2<sup>1</sup>/<sub>2</sub>.—Manchester Edison and Swan Company, £9, (£1 paid), 11/- — 12/-.

REPORT ON THE LINEFF ELECTRIC  
TRAMWAY SYSTEM.

I HAVE examined and tested the new Lineff Electric Tramway system, with underground conductor, at the dépôt of the West Metropolitan Tramway Company, at Chiswick.

The main feature of the new Lineff system is the employment of a conductor placed in a conduit or channel closed on all sides, so that no slot or other opening in the road is required for establishing electrical communication between the generating dynamos at the power station, and the propelling motor on the car. This communication is established by means of short pieces of insulated rail, laid between and parallel with the ordinary tram rails, and a continuous conductor placed below the insulated rails, in a channel or conduit formed of insulating materials. The conductor consists of naked copper strip or cables upon which is laid a strip of galvanised iron. There is a small interval between the upper surface of the iron strip and the lower surface of the insulated or third rail, and the latter is not in electrical communication with the power station as long as this interval is maintained. This is the case on all portions of the line not occupied by cars, and therefore the third rail may, where accessible, be walked upon or touched without the slightest danger from electrical shocks. Immediately under the car, however, two or three sections of the third rail are in contact with the buried conductor, and become thus charged to the potential of the latter. This contact is produced by magnetic action, which draws the iron strip up, and presses it against the lower flange of the short pieces of insulated rail, which thus become part of the conductor, from which the current is picked up by contact wheels and led to the motor on the car. The return circuit is, as usual, through the rails and earth. As the car travels along, the underground iron strip is dropped behind and picked up in front, thus maintaining continuity of connection with the power station over its whole journey, whilst, at the same time, leaving the track in front and rear of the car perfectly free from electrical charges. The magnetic action between the insulated rails and underground conductor is produced by an electro-magnet carried under the car. This electro-magnet is ordinarily energised by a current obtained from the conductor, but it can also be energised by a current obtained from one storage cell, so that the conductor, should it accidentally have been dropped, may be picked up at any point on the line.

The car employed was an open summer car, carrying 20 passengers, besides driver and conductor. I estimate the weight of car, as fitted with a 4 H.P. motor, chain gear, magnetic brake and other accessories, at 35 cwt., without passengers.

The object I had in view when making the tests, of which I give a detailed account in the appendix to this report, was to ascertain whether the Lineff system in its present form is likely to prove successful in practical work. The answer to this question depends mainly upon three considerations, viz., safety to the public, efficiency of service, and economy of working. I deal with these considerations separately.

## SAFETY TO THE PUBLIC.

The car, when running at full speed, can be stopped within a distance of 9 feet, or less than its own length. This power of control is amply sufficient for practical purposes. There remains the further question, whether there is any danger of persons or animals receiving shocks from stepping upon the insulated rails in front or behind the car.

The length of an ordinary car is 21 feet, so that the nearest accessible point of the insulated rail is about 11 feet from the centre of the car. My experiments lead me to conclude that the charged region of the insulated rail can, at all speeds, be restricted to within about 9 feet in advance and behind the centre of the car, leaving 2 feet of rail under the car at either end, and all the rail beyond the ends free from electrical charge, so that there is no danger of persons or animals receiving shocks from the rail.

The collection of current from the magnetic rail is so arranged as to avoid sparking.

## EFFICIENCY OF SERVICE.

I found the magnetic picking-up gear perfectly reliable, both on the straight single line and on a branch or crossing. I have already mentioned that as a further precaution against losing the current each car will be equipped with a storage cell for picking up, and there will thus be no danger of a car losing its propelling power and blocking the road.

## ECONOMY OF WORKING.

Compared with a car worked by an overhead line, the present Lineff car will require from  $\frac{1}{3}$  to  $\frac{2}{3}$  of a horse-power more, but as electric tramways on the overhead wire system are inadmissible for urban and suburban traffic, the comparison must be made either with an underground slot system or with cars propelled by storage batteries. As regards the former, there is no perceptible difference in power between it and the closed magnetic channel system. With storage cars, the power required is however considerably in excess of that required with the closed magnetic channel, for the simple reason that, in addition to weight of car, motor, and passengers, the weight of the storage cells must also be taken into account. With the Lineff system  $7\frac{1}{2}$  horse-power will be required to propel a full-sized car at 7 miles per hour. To propel the same car by storage batteries would require carrying an additional weight of 3 to 4 tons, and an expenditure of about 12

horse-power. Making due allowance for the loss of power in charging and discharging the storage cells, I find that the total amount of steam power required at the station would, with storage cars, be about double that required by the Lineff system.

## NOVELTY.

With regard to the novelty of the Lineff magnetic conductor, I may add that although magnetic action has been used before by several inventors for actuating switches which establish electrical contact between a sealed main and separated lengths of surface rails, yet the idea of a continuous magnetic conductor forming, so to say, one single switch for the whole line, is entirely novel and strikingly simple. The arrangement of magnetic rails on the hit and miss principle is also entirely new, and secures a great economy in the energy necessary to effect the attraction of the continuous magnetic conductor.

This part of the invention especially has been worked out with great skill and care, as is amply testified by the good results obtained under the very unfavourable conditions imposed by the necessities of road traffic and by other mechanical considerations. The fact of having one set of magnetic rails only exposed on the surface, each length in turn becoming of north and south polarity, is novel, and will greatly help the adoption of this system in preference to those where two sets of exposed rails are required to close the magnetic circuit. The arrangement of blind rail, which performs the same office as if it were on the surface of the road and under the direct influence of the magnet pole, is very ingenious and effective.

The mechanical strength of the magnetic channel and of the line generally, was tested by taking a steam roller over it. The line was not damaged thereby in any way, either mechanically or electrically, and I consider the result of this test highly satisfactory.

As a general result of my investigation, I have come to the conclusion that the Lineff closed magnetic channel system is now ripe for practical application.

(Signed) GISBERT KAPP.

—, Parliament Street, Westminster,

June 12th, 1890.

## APPENDIX TO REPORT.

The tests upon which my report is based were made on the 29th and 30th of May, and the 3rd, 10th and 11th of June, 1890.

I deal in this appendix with the various points in the same order in which they occur in the report.

## SAFETY TO THE PUBLIC.

The extent of "charged region" on the insulated rail was tested in the following manner:—The positive lead feeding the glow lamps on the car was disconnected from the main positive terminal, and connected to a flexible conductor terminating with a contact piece or pilot brush. The latter was attached to a wooden bar which could be set so that contact was made with the insulated rail at any given distance from the centre of the car. When the point of contact was on a charged or "live" rail the lamps lighted up; when on a "dead" rail they remained dark. By varying the distance of contact it was thus easy to ascertain the extent of the charged region on either side of the centre of the car. I found that the length of charged region varies at different points of the line, which may be due either to a variation in the thickness of the hoop iron (this being of two different gauges on the line), or to a variation in the thickness of its zinc coating, which, if too thin, would not allow the hoop to drop instantly. I also found that there was some uncertainty in the lamp test if the contact between the pilot brush and live rail lasted only a fraction of a second. In such cases the lamp filaments had not time to become so hot as to be distinctly visible, and I replaced in subsequent tests the lamps by an electric bell, which gave indications with contacts of so short duration as to escape detection by the lamp test. The result of these tests, which were made at various speeds, and over a continuous piece of line 68 feet long, are given in the following table.

Extent of Charged Region behind the Centre of the Car.	Speed in Miles per Hour.			
	1	8	7	
7 feet 6 inches ... ..	live	live	live	live
8 " 3 " ... ..	live	live	live	live
8 " 6 " ... ..	live	live	live	live
9 " 0 " ... ..	dead	dead	dead	dead
9 " 6 " ... ..	dead	dead	dead	dead
10 " 0 " ... ..	dead	dead	dead	dead

There remained still the question whether the wave running along the hoop iron under the car might induce subsidiary waves in it at greater distances than 10 feet from the centre, either in front or behind the car. If this were the case, there would be danger of the magnetic rail becoming "alive" at points when ordinary traffic passes over it. I have tested this question by short-circuiting the magnetic rail to earth at various distances both in front and behind the car, and whilst the latter was running and standing, and in no single case have I found a "live" section of magnetic rail.

I also investigated the question whether it will be possible to collect the current from the magnetic rail without sparking, as otherwise horses might be frightened. In the original management, the collection of current was effected by the contact of the wheels supporting the electro-magnet on the magnetic rail, and with a dry and clean line, or with a dirty and wet line, there was no perceptible sparking. If, however, the line, when dry, was

covered with dry sand, gravel, and clinkers, there was sparking, and to avoid this defect, I advised Mr. Lineff to fit wire brushes to the pole shoes, so as to obtain more perfect contact. This has been done, and in a subsequent test no perceptible sparking occurred with any condition of line.

#### EFFICIENCY OF SERVICE.

The efficiency of service depends upon the power required to propel the car, and upon the possibility of maintaining the line in proper working order. As regards the power required for the car itself, apart from that absorbed by the apparatus for collecting the current, there is no reason why the Lineff car should require either less or more power than any other electric car of equal weight, and geared to run at the same speed. I have therefore only to investigate what extra amount of power is absorbed by the apparatus for collecting the current, and what amount of power is lost by underground and surface leakage.

The power required for the current collecting apparatus may be regarded as lost to propulsion, and this loss consists of three items:—

#### 1.—Imperfect Contact between Magnetic Rail and Wheels of Electro-Magnet.

I measured the difference of potential between the magnetic rail and the car terminal when the working current of 11 amperes was passing. The drop of E.M.F. thus found varied with the condition of the line. It was .3 of a volt when the line was watered, but otherwise clean; .7 when the line was clean and dry; and 2.7 when the line was dirty with mud, horse dung, sand and clinkers. These tests were all made before the brushes above mentioned had been fitted, so that with the improved contact this loss of power may be considered as insignificant.

#### 2.—Power Required to Energise the Electro-Magnet.

The resistance of the two magnet coils and a third external coil is 220 ohms, and the working pressure 230 volts. The power absorbed in the three coils is therefore  $\frac{230}{220} \times 230 = 240$  watts, of which 160 watts are required for the magnet and 80 watts wasted in the external coil. These 80 watts could be saved by rewinding the two magnet coils with finer wire. The energy expended in "picking up" is therefore 160 watts.

I had previously tested the magnet and found that 60 watts is the minimum of energy required for picking up, but to make sure of always maintaining the circuit, 160 watts have been allowed. During my test of the line, there has been no case of failure to maintain the circuit.

#### 3.—Power Required to Propel the Electro-Magnet.

This was tested by hauling the magnet alone along the line, a spring balance being inserted into the hauling rope. I found the resistance to be 19 lbs. when the magnet was not energised, and 27 lbs. when it was energised. At seven miles per hour this represents an expenditure of about half a horse power. It appears desirable that this loss of power should be reduced, which can be done either by employing larger wheels and improved axle bearings on the electro-magnet, or by so suspending it from the car, that part of its weight is taken by the car.

In the workshop there has been erected a full size working model of the magnetic rail as arranged for a switch or branch line. After the tests on the line on the 30th May were completed, the electro-magnet was detached from the car, taken into the workshop, and run over the magnetic rail containing a branch line. The current-collecting apparatus acted perfectly, and there was no failure to maintain the circuit either on the main or on the branch line.

#### ECONOMY OF WORKING.

I have now to consider the amount of power lost by underground and surface leakage. The former takes place over the whole length of the line, and is independent of the number of cars in use at any time, whilst the latter is confined to the three charged sections of magnetic rail under each car, and is therefore proportional to the number of cars in use at any time. The insulation resistance of the conductor was tested both by the bridge method (48 Leclanché cells, Post Office pattern bridge, and mirror galvanometer), and by passing the leakage current through a voltmeter. The two methods gave fairly accordant results, but the insulation varied on different days considerably. The highest reading I recorded by the voltmeter test, when the full pressure of 230 volts was on the conductor, was 5,400 ohms, and the lowest 3,550 ohms. In order to maintain the underground conductor in a proper working condition, I consider it desirable and possible to increase its insulation resistance. But for the determination of loss of power by leakage, I take the figures as I find them, disregarding any future possible improvements in insulation. From these figures it appears that the average insulation is 4,475 ohms. Since the line is 220 feet long, the insulation resistance of one mile of similar line will be 186 ohms. Assuming the working pressure to be 300 volts, the leakage current would be 1.61 amperes, and the power thus lost would be 482 watts, or about two-thirds of a horse-power. This loss in itself is not an important item. It is, in fact, negligible in comparison with the power which is required for the propulsion of the cars on a mile of line.

Another source of loss of power in electric traction is surface leakage. To ascertain this, I also applied the voltmeter test, and found the following insulation resistances of three charged sections

of magnetic rail. With the line clear and moist, 4,183 ohms with the line very wet and covered with mud and horse droppings, 980 ohms. Taking 2,000 ohms as an average, I find that at a working pressure of 300 volts, the loss of power by surface leakage per car amounts to 45 watts, which is quite insignificant.

As regards the question whether it will be possible to maintain the line in proper order when subjected to the wear and tear of ordinary street traffic, I am of opinion this can only be decided by actual trial extending over a considerable time. As far as it was possible to do so, in an experiment extending over a few days, I have tested the line both as regards mechanical strength and insulation. I have already mentioned that the resistance varied between 5,400 and 3,350 ohms during the time over which my experiments extended. An average insulation of 4,475 ohms per 220 feet, or 186 ohms per mile, would not be too low if the only consideration were that of the waste of power entailed by leakage, but experience shows that when the insulation of a line is initially low, there is probability of its becoming still lower in the future, and for this reason I consider it desirable to improve the insulation of the line. I am of opinion that this can be done in two ways—first, by an alteration in the shape and arrangement of the earthenware supports of the conductor, and, secondly, by blowing dry air through the channel. This will necessitate the employment of air compressor at the power station, but the additional capital outlay and working expenses will be trifling in comparison with the advantages of good insulation, which will be obtained thereby. The mechanical strength of the closed channel was tested by taking a steam roller both across and along the line. Since the magnetic rail is slightly higher than the running rail and surrounding pavement, the whole weight on one of the driving wheels of the steam roller (which I estimate at 5 tons) was thus supported by the magnetic rail. The steam roller was driven backwards and forwards, over and across the magnetic rail, to see whether any mechanical damage could thus be done to it. I could not detect any deformation or other damage done to the magnetic rail or the bitumen channel, and, so far, the steam roller test was entirely satisfactory. There remained still the possibility that, through the application of a concentrated pressure of 5 tons, minute cracks, invisible to the naked eye, might have been developed which would admit moisture, and thus impair the insulation. To test this point, I had the line drenched with water, but, as shortly afterwards it began to rain, I discontinued the artificial application of water. The rain lasted on and off during the remainder of the day and following night, and in the afternoon of the following day I had the insulation of the line again tested by my assistant. He reported 3,400 to 3,800 ohms. Before taking the steam roller over the line the insulation was 3,400 ohms. If the mechanical strain had developed cracks in the bitumen, there would have been sufficient time for water to percolate in the interval of 26 hours which elapsed between the two resistance tests. Since, however, the second test showed the same if not a higher insulation than the first, it is evident that no damage was done to the line by the steam roller, and I consider the result of this test very satisfactory.

(Signed) GIBBERT KAPP.

31, Parliament Street, June 12th, 1890.

## THE ELECTRIC LIGHT AT BATH.

SEVERAL deputations from representative bodies in London and the provinces have visited Bath to inspect the electric light works and the public arc lamps. A serious leak which occurred on the night of the 8th inst. affected more or less 40 out of the 81 public lamps. Directly the leak was discovered, steps were taken to localise its position, but, owing to the very short nights, this was not completed until nearly the time for ceasing lighting. In reporting the mishap to a committee of the Town Council, Mr. Massingham wrote: "The leakages that I have discovered so far are due to the movable connections between the underground mains and the lamps for the purpose of raising and lowering the lamps and so dispensing with ladders. Major Cardew, R.E., recently inspected the whole of the electric installation on behalf of the Board of Trade, and appeared extremely well satisfied with it as a whole, but suggested that it would be impracticable to make the raising and lowering arrangements absolutely safe, and advised my adopting fixed lamps and conductors and using ladders to reach them, which would be far more reliable from an electrical point of view. As the practical experience of the past fortnight confirms his views, I have decided to dispense with all movable arrangements, and have given instructions to Messrs. Callender & Co., who laid the underground mains, to carry this out with all possible speed. The work is now in hand and, I hope, will be finished within three weeks." The letter was regarded as satisfactory. The Christopher Hotel is lighted by means of electricity from the Bath Electric Light Works. The light is also being introduced into the York House Hotel.

**Accumulator Question in Paris.**—The adoption by the Northern Tramway Company in Paris of the the Société Française d'Accumulateurs Electriques system has been followed by an order for 40 more cars.

## THE COMPOUND WINDING DYNAMO MACHINES.

KING, BROWN & Co. v. ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.

IN the Court of Session, Edinburgh, on Wednesday, the 16th inst., the First Division disposed of a reclaiming note in the above case. It was originally brought in the Outer House by King, Brown & Co., Rosebank Electric Works, Edinburgh, against the Anglo-American Brush Electric Light Corporation, London and Edinburgh, for reduction of letters patent granted to Mr. Brush in 1878 for the exclusive right of making dynamo-electric machines of the compound winding type. Lord Trayner, in the Outer House, found that Brush's patent, having been anticipated by Varley, was invalid, and he, therefore, decided the case in favour of the pursuers, with expenses. The defenders reclaimed to the First Division of the Court, and the case was heard before the Lord President, Lord Adam, and Lord McLaren. Judgment on the reclaiming note was given on Wednesday.

Lord McLaren said: The defenders, the Brush Electric Light Corporation, claim under their patent the exclusive privilege of making dynamo-electric machines, in which the electro-magnets are of the type known as "compound wound" magnets; also known as the "series shunt" type. The pursuers, King, Brown and Co., are makers of "compound wound" dynamos; and their right to make such machines having been extrajudicially challenged they have brought this action to have the defenders' patent reduced and declared void on various grounds; the chief objection being that the invention of compound winding was previously discovered and made known by Mr. Varley, and consequently that Mr. Brush, or his assignees, are not in the position of being the "first and true inventors" of this valuable electric appliance. There can be no doubt that the holders of Brush's patent claim compound winding as an essential feature of their machine; and, accordingly, if this claim be ill-founded, the patent must fall. The argument was directed mainly to the question of the anticipation of the Brush system of compound winding by Mr. Varley, and I shall consider this subject in the first place, touching afterwards on the objections to Brush's specification, which are of a technical character. In order to make my observations intelligible, I must begin by stating in what compound winding consists:—When the armature of an electro-magnet is attached to an axis, so as to be capable of rotating in the magnetic field, the armature tends to place itself in a symmetrical position with reference to the poles of the magnet, and if force is applied to turn the armature on its axis, the movement of rotation is resisted by the forces in the magnetic field. The energy expended by the steam power, or whatever power is employed to turn the armature against the resistance of the magnetic field, is then converted into current electricity; and the current being carried through the revolving axis by insulating wires, is given off by an appliance termed the commutator, passes thence into a conducting wire, and is then ready to be used for electric lighting, or any other purpose of utility to which it is capable of being applied. In the rudimentary form of the dynamo machine, I understand that the excitation of the electro-magnets was maintained from a separate, or, as it is termed, an external source, generally a battery of some kind. The first improvement consisted in winding one of the conducting wires round the electro-magnet, the continuation of this wire being led into the external or working circuit. In this way the current flowing from the dynamo was made to maintain the magnetism of the electro-magnets as a part of the work which it had to perform. This is known as series winding, because there is one continuous current which is only partly used in maintaining the magnetism. The next improvement consisted in dividing the current as it flowed from the commutators into two partial currents. In this system the wire is bifurcated; one branch is wound round the electro-magnet, and is returned to the opposite poles of the commutator. The second branch wire is employed for lighting or external work of some kind, and is reunited to the first branch wire near where it meets the commutator at the opposite pole. This is the form known as the shunt winding system, or shunt machine. The invention of compound winding, with which we are here concerned, consists in, I will not say a combination of the two methods, but in the addition of the shunt and series method. The wire is divided or bifurcated as it leaves the commutator. Both the branches are wound round the electro-magnets. One of these is directly returned to the opposite pole of the commutator without doing any work other than the excitation of the magnets. The second wire, on leaving the electro-magnets, is continued to form the external or working circuit, and is ultimately re-united to the first wire. This arrangement seems to be an exception to the rule against trying to do two things at the same time, because it is admitted that the compound wound machine is a much better working machine than the shunt. It appears that the sections of the wires can be so proportioned that an early uniform current flows in the working field, notwithstanding variations in the quantity of work to be done. It is not necessary for the purposes of the case to explain why this should be, and if it were necessary, I am not sure that I am able to explain it. It is a question of the mathematical theory of current electricity. But it is agreed that the compound wound machine, when the wires have the proper relative conducting capacity, gives better results as regards uniformity and steadiness

of the current than are attained by either the series or the shunt, and this explains the importance of the right to use this invention to the parties concerned. I may here observe it is not clear to me that either Varley or Brush were at first fully aware of the scientific and practical importance of the principles of compound wiring. Varley was the inventor, or one of the inventors, of the "series" machine, and both Varley and Brush were doubtless aware of the advantages and disadvantages of the "series" and the "shunt." The idea of introducing the two methods into the same machine is one that would very naturally occur to any one familiar with the subject, and practically conversant with dynamo machines. Assuming that this is intelligently done, with the object of getting a better working machine through the union of the series and the shunt than is attainable by either of these modes of winding singly, then the invention is a proper subject of a patent, and it is not necessary to its validity that the patentee should have foreseen all these advantages which have been realised through the subsequent introduction or extension of electric lighting with the incandescent lamp. I may also observe that in Brush's specification, as well as in this specification, the mode of winding is only treated as one among many other parts of a dynamo machine; and it is quite possible that a reader, even if conversant with the subject, might peruse either of these documents without having his attention specially called to the novelty of the system of compound winding. But neither will this consideration affect the question. An inventor may describe his invention clearly without proclaiming it as a very important discovery, and the question is whether compound winding is clearly described in Varley's specification. The specification in question is No. 4,905 of 1876, and its title is—"Improvements in apparatus for producing the electric light, parts of which invention are applicable to other purposes." The alleged anticipation is contained in the two paragraphs, page 4, lines 11 to 21—"Part of the electricity developed by the machine is diverted to maintain the magnetism of the soft iron magnets, and the remaining portion is used to produce the electric light." I interrupt the reading to remark that in the words I have read the writer only announces what he is going to do, and does not profess to be explaining his method. This obvious, and I should have thought, superfluous criticism disposes of many pages of evidence in which witnesses are brought to say that these words would not give them a clear idea of the method of winding. The specification proceeds—"There are several well-known ways of doing this" (that is, of diverting a part of the electric energy developed by the machine), "but the method I prefer is to wrap the soft iron magnets with two insulating wires, one having a larger resistance than the other. The circuit of larger resistance is always closed, and the circuit of less resistance is used for the electric light." If the description had stopped here I should not have doubted that it contained a clear description of the construction of a compound wound machine—I mean a description of so much of the apparatus as is included in the name compound winding. The direction is to wrap the magnets with two insulated wires. It is, of course, implied that these wires are to carry currents coming from the machine; but this is not left to implication, because it is clearly explained that these insulating wires are the media for the transmission of separate currents, the one of larger resistance being always closed (in other words, acting as a shunt); while the other is used for the electric light (having previously contributed to the magnetisation of the magnets by being wrapped around them). But if the description had stopped here it would have been open to the observation that while it described the construction it did not indicate, except in a very general way, the use of the compound winding of the magnets. Now, I could hardly consider that to be an adequate description of an invention which should leave the reader in ignorance of its utility and its mode of action. But the information which I desiderate is supplied by the second paragraph: "When the electric light is being produced the greater portion of electricity passes through the circuit of less resistance, which I term the 'electric light circuit,' maintaining the magnetism of the magnets, and producing the light. When the electric light circuit is open from any cause, the electricity developed passes through the circuit of greater resistance only, and maintains the magnetism of the magnets." There is here plainly described one of the advantages of the compound wound dynamo, probably the only one known to the writer, viz., that when work is being done in the external circuit, the magnets have the benefit of the unobstructed flow of the electric current through the wire of larger resistance and less resistance, while when the external circuit is open and no work is being done, the magnets receive through the wire of greater resistance the current, which is sufficient for their excitation. I am here merely paraphrasing Mr. Varley's description without meaning to add anything to it, and I think that anyone conversant with the subject, and reading this paragraph (whether he agreed with Mr. Varley or differed with him as to the possible benefits to be obtained), would not be left in doubt as to what Mr. Varley considered to be the rationale, and the mode of action of the arrangement of wires described in the preceding sentences. I have difficulty in understanding how it is that a considerable number of able and distinguished men should have been persuaded to give their evidence as to the alleged insufficiency of Mr. Varley's description as an anticipation. To a considerable extent the evidence of the witnesses of the Brush Company is made up of somewhat minute and verbal criticism on the expressions used by Mr. Varley. But, in so far as these gentlemen indicate an opinion as to the insufficiency of the description in its entirety, I think their conclusions are, in part, explained by their having misapprehended the question, because I observe that

the question is frequently asked, and answered, whether Varley's specification is such as would enable an ordinary workman to make a compound wound machine. Now the question of anticipation does not depend (in our opinion) upon that test. We are not here trying the sufficiency of Varley's specification as a specification. Varley is not here claiming any exclusive privilege (his patent has long since expired), and we have no occasion to consider whether he fulfilled the duty which is the counter-part of the exclusive privilege given to a patentee of particularly describing and ascertaining the nature of his invention, and the manner in which it is to be performed. I am very far from saying that Varley's specification is insufficient as a specification of a patented invention. I rather think it would be held to meet the requirements of the statute of King James. But the question we are now considering is quite different: it is whether Mr. Brush is or is not the first and true inventor of compound winding; and the negative of that proposition may be proved by showing that the invention was previously described, not necessarily in language sufficient as a direction to a mechanic; but in language clear and intelligible to educated men conversant with the subject, and capable of giving the necessary directions to the hypothetical workman. An invention may be clearly described in mathematical or chemical symbols; the latter being, perhaps, the preferable illustration. Such a description, although it may have to be translated for the instruction of the operative chemist (just as if it were written in a foreign language) would be an anticipation of the same invention described in popular language, such as is required (as far as practicable) by our Patent Law. Now I venture to think that if Varley's description had been put into the hands of any of the defenders' witnesses (without reference to any question under the Patent Laws) that he would have understood it, and would have been able to instruct a workman to make an experimental machine. I think I can collect from their evidence that the witnesses on both sides understood the specification perfectly, although some of them were certainly apprehensive that other persons, less gifted, would not find it so easy to be understood. It is a remarkable circumstance in this case that neither in the course of the trial, nor in the argument addressed to us, has any reference been made to Brush's description of compound winding. It seems to have been assumed that it, at least, was a pattern of clearness, and certainly no objection was taken to it on the ground of insufficiency. Brush's description is contained in the following passage in his specification:—"In applying my invention to dynamo-electric machines, I wind the cores of the field magnets with a suitable quantity of a comparatively fine wire, having a high resistance in comparison with that of the external circuit, and the rest of the wire in the machine. The ends of this wire are so connected in the other parts of the machine, that when the latter is running a current of electricity constantly circulates in said wire, whether the external circuit be closed or not. The high resistance of this wire prevents the passage through it of more than a small proportion of the whole current capable of being evolved by the machine; therefore the available external current is not materially lessened. When this device, which I have called a 'teaser,' is used in connection with field magnets, also wound with coarse wire for the purpose of still further increasing the magnetic field by employing the main current for this purpose in the usual manner, then the 'teaser' may be so arranged that the current which passes through it will also circulate in the coarse wire, thus increasing the efficiency of the device." Now if Varley's description be insufficient, I do not see how the validity of Brush's patent can be maintained, because the two descriptions are practically identical. Conversely, if the invention of compound winding be well described in Brush's specification, the identical description in Varley's specification must be an anticipation. I do not mean, of course, that the language of the two descriptions is absolutely identical. In describing the shunt arrangement, Brush calls it a "teaser" (I do not know whether electricians attach any significance to this vocable), and there are some other variations of expression. But I can find nothing of substance in Brush that is not in Varley, and I cannot help adding that if there be any difference Varley's description is the more easily understood of the two. This completes what I have to say on the subject of anticipation by prior publication. There is also a plea of anticipation by prior use. On this point the facts are these:—In the interval between the filing of the provisional and complete specifications Mr. Varley had a machine made to his direction by the firm of Siebe and Gorman. When the machine was first tried it did not work well, because its frame was not sufficiently strong to prevent the revolving armature being attracted into contact with the electro-magnets. I need not say that the motion of the armature must not be resisted by friction, but only by the immaterial, though not less real resistance offered by the forces developed in the magnetic field. This was corrected by strengthening the frame, and the machine was successfully used in the production of an arc light by the lamp produced along with the machine. Siebe and Gorman are makers of diving apparatus, and the lamp was used on their premises to exhibit the apparatus under water in a tank which they had for the purpose. The case on public use is narrow, but we consider that what I have described is public use as interpreted by decisions. The machine in question was produced, and it is a compound machine; nobody has said anything to the contrary, though some of the defenders' witnesses say that if the wires were uncoupled, or were coupled up in a difficult way, it would no longer be so. But the effect of uncoupling the shunt wires would be to render this part of the winding simply useless for any purpose, as would indeed be the case with a machine of any kind if a material part

of the mechanism is taken out of its place or turned the wrong way. The Lord Ordinary has, in his judgment, extracted some of the more noticeable expressions of opinion by the scientific witnesses on the questions of prior publication and prior use, and has pointed out the insufficiency of the reasons given for holding Varley's specification to be incorrect or incomplete. I concur in the Lord Ordinary's view as to the weight to be attached to this part of the evidence, and, in his lordship's opinion, generally on the facts of the case, except in so far as he may be held to imply that the test of the sufficiency of an anticipation is the same as the test that would be applied to the construction of a specification founded on as such. There is another objection to the defenders' patent, and it is founded on an alleged inconsistency between the provisional and the complete specifications. The provisional specification announces, as one of the improvements for which the patent is granted, an improved construction of the commutator. The function of the commutator is to convert the alternating currents (as they pass from the revolving axis to the external circuit) into one continuous current. This is accomplished by fitting the axis with insulated segments, to which the poles of the armature are connected by insulated wires, and these segments are so arranged that at the moment when the current in the machine is reversed, the external wire becomes disconnected from the corresponding segment, and is at the same time brought into connection with the segment which is attached to the opposite pole of the armature. The improvement indicated in the provisional specification is a purely mechanical improvement for the purpose of obtaining a mechanical advantage. But, in the course of perfecting his invention, Mr. Brush found that an electrical advantage might also be secured by means of a slight variation of the mechanical arrangement indicated in the provisional specification. The variation consists in separating the segments, so that for a small fraction of each semi-revolution the current shall be interrupted; that is to say, the current is cut off during the brief interval when the armature (or the particular member of the compound armature) is in a neutral position, and when the resultant of the forces acting on it is therefore very small. In the complete specification, the variation whereby this electrical advantage may be gained is claimed as one of the patented improvements, and the question arises whether this difference between the provisional and complete specifications does not exceed the latitude allowed to an inventor who is only perfecting what he has provisionally announced. The Lord Ordinary has held that the claim referred to is not covered by the provisional specification on the ground that, although the construction of the commutator as perfected is not materially varied, yet, as the variation represents a distinct principle, and is directed to an object distinct from that which is indicated in the provisional specification, the two things cannot be regarded as identical inventions. There is much force in the Lord Ordinary's view on this question; but we consider it unnecessary to come to a decision upon it, because we are all of opinion that if there had been no more serious objection to the Brush patent than this, it would be only fair to the patentee that he should be allowed an opportunity of disclaiming this variation on one of the patented improvements. But this is not the condition of the case as it arises for decision, because we are agreed that the patent is invalidated in its essential and fundamental privilege by reason of the prior publication and prior use by Varley of the invention of compound winding, for which this exclusive privilege is given. For these reasons I am of opinion that the interlocutor of the Lord Ordinary should be adhered to, and decree of reduction of the patent pronounced.

THE LORD PRESIDENT: That is the opinion of the Court.

On the motion of Mr. DANIELL, counsel for King, Brown and Co., the Brush Corporation were found liable in expenses.

## PROCEEDINGS OF SOCIETIES.

### The Institution of Electrical Engineers.

"Observations on Currents originating in ordinary Aerial Telegraph Conductors,"\* by A. R. BENNETT, Member.

All users of telephones connected by single wires are familiar with the variety of noises which are generally present, even when the line is only a few hundred yards long. It is exceptional to find a wire which can be said to be even approximately silent at all times. The origins of some of the foreign currents which the presence of these noises indicates, have been explained by Preece, Lockwood and others. Recently in testing some overhead copper and iron wires run on the same poles for capacity by charge and discharge, using a sensitive reflecting galvanometer, the author noticed the presence of currents which could not be accounted for by any of the known explanations, and the causes of which he determined to investigate.

It was noticed that soon after the commencement of rain, a steady current appeared on all the wires under test. The deflections increased as the rain continued, until, after the thorough soaking subsequent on several days' wet, they were in some cases no

\* Paper read at the special meeting of the Institution of Electrical Engineers, held in the Lecture Hall, Edinburgh International Exhibition, July 15th, 1890.

longer within range of the scale. A constant discrepancy in the behaviour of copper and iron wires was apparent. The deflections from the copper were always positive, while those from the iron were always negative, and as invariably much feebler, seldom exceeding one-third the strength of the positive ones.

To ascertain the cause, two wires, one No. 12½ copper, and the other No. 11 galvanised iron, run side by side on the same arms for the distance of a mile (fig. 4) were taken. In fine weather the insulation resistance of each was infinite.

When disconnected at the farther ends and earthed at the home end through the reflecting galvanometer (fig. 1), they always in wet weather exhibited the phenomena described.

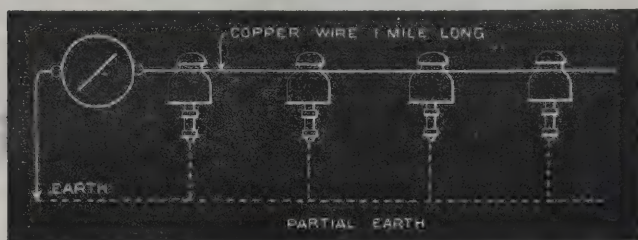


FIG. 1

The following are extracts from the records of tests extending over several months, during medium and heavy rain:—

Copper.—Always positive.		Iron.—Always negative.	
Degrees.	Value of deflections in milliamperes.	Degrees.	Value of deflections in milliamperes.
4.5	.0030375	1.5	.0010125
13	.008775	3.75	.00253125
20.5	.0138375	4	.002700
17	.011475	3	.002025
15	.010125	4.5	.0030375
3	.002025	.5	.0003375
46	.031050	17.5	.0118125
22	.014850	7	.004725
14.5	.0097875	3.5	.0023625

It will be observed that the copper deflections were always from three to six times stronger than the iron ones. When the copper and iron wires were left insulated at their distant ends, and looped through the galvanometer (fig. 2), earth being excluded, the positive and negative deflections were always equal. Thus, taking the last three of the foregoing tests, when looped 46 + 17.5 — became 35 + 35 —; 22 + 7 — became 12.5 + 12.5 —; 14.5 + 3.5 — became 9.7 + 9.7 —.

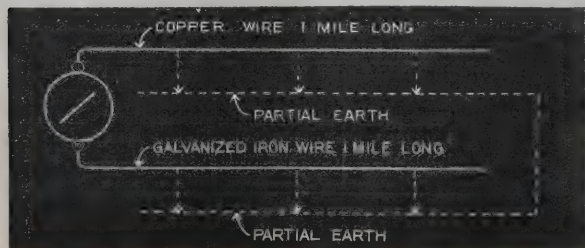


FIG. 2.

Half-a-dozen insulators with galvanised iron bolts were mounted on an arm in the testing room, and thoroughly wetted (fig. 3). With a copper wire run on them, and the bolts connected, as shown, a positive current appeared as soon as a film of water was established between the wire and the bolt. With an iron wire instead of the copper no current appeared.

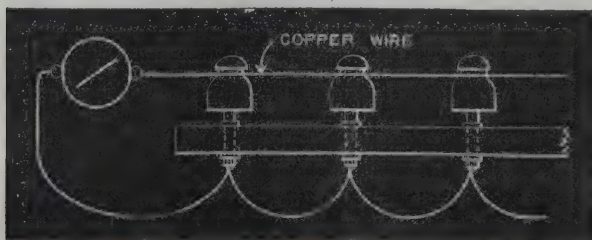


FIG. 3.

The positive current, therefore, seemed to be due to voltaic action between the copper wire on the insulators and the galvanised iron bolts supporting them when connected with the moist surface. The course of the current can be traced in fig. 1. The

wire and insulator bolts form a series of voltaic cells joined in parallel.

The absence of a current from the iron when mounted on the experimental arm confirmed this conclusion, since no current was to be expected under the conditions. But whence, then, the negative current from the iron wire run on the actual poles? In that case it had a copper wire strung alongside it (fig. 4). The wetting of both insulators established the connection necessary for electrolytic conduction between them, so that the metals constituted a voltaic couple, the negative current from which appeared on the iron.

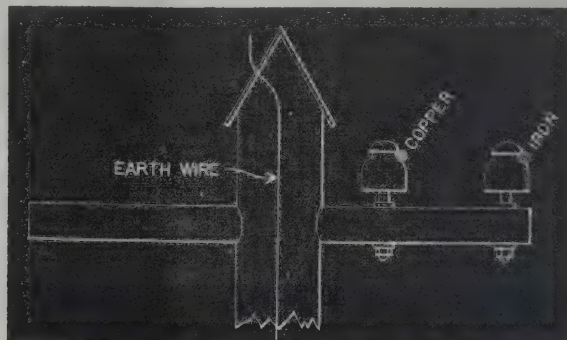


FIG. 4.

The positive current on the copper was consequently due to the copper wire acting with the iron bolts of its own insulators, the iron bolts of the neighbouring insulators and the iron wire which they supported.

The negative current on the iron was due to the iron wire, its bolts, and the bolts of the neighbouring insulators, acting with the copper wire. But the bolts of the insulators (fig. 4) were partially earthed by the damp wood of the poles and the earth wires which ran down them. If the earth had been perfect no current could have got to the galvanometer, but since it was only partial some found its way by that route; and so the difference in strength between the positive and negative currents is accounted for.

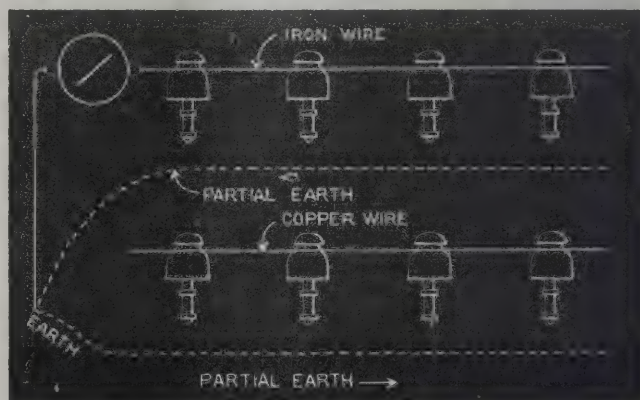


FIG. 5.

The positive, depending chiefly on the action between the copper wire and its own bolts, between which no earth intervenes, is necessarily stronger than the negative, which depends wholly on the action between the iron wire and bolts and the copper wire between which a partial earth is interposed (fig. 5). So when the earth is cut off from the galvanometer (fig. 2), the effect of the earth between the two plates is neutralised, and the positive and negative deflections become equal.

A somewhat unexpected effect of the recent introduction of copper wires for telegraph and telephone purposes is consequently the establishment over the country of a vast number of voltaic couples, which only become operative in damp or wet weather.

The zinc of the bolts of insulators carrying copper and bronze wires may reasonably be expected to disappear sooner than in days gone by when only iron wire was used; and when copper and iron wires are run on the same poles the galvanising of the iron must suffer sooner than of yore.

The Americans, with the wooden pins, will escape the currents due to the difference of metal between the wire and its supports; but when they mix wires of different metals on the same poles the resulting action will be stronger than with us, since they do not earth-wire their posts.

Telephonically, the existence of these currents is of little moment. With metallic loops when both wires are of the same metal, they will not matter at all, since the currents from two similar wires will be in the same direction and of the same strength, and, meeting in the telephone or translator will neutralise one another.

On single wires, so long as the currents remain steady, their presence does not matter much. As they increase gradually as the insulators become wet, and die away slowly as they dry, they

do not give rise to any disturbance in the telephone. If any confirmation of the voltaic origin of these currents were needed, it would be afforded in the fact that it is possible by changing the line from a battery, to polarise the line couple even to the extent of obtaining temporary currents of the opposite sign. Thus, the copper was repeatedly changed from a 90-volt battery; when from the positive pole the line current was increased, when from the negative the line current was decreased and sometimes reversed.

The following are particulars of several tests of the copper wire, the deflections being in degrees:—

Charging wire from 90 volts, &c., to line so as to neutralise and overcome line current.

Line current.	Duration of charge.	Result.
5 +	10 seconds.	Reversed to 2 -
6 +	20 seconds.	Reduced to 5 +
8.4 +	4 minutes.	Reduced to 3.5 +
12.5 +	10 seconds.	Reversed to 2 -
		Spot went back instantly to 5 +, and then recovered slowly to 12.5 +
12.5 +	20 seconds.	Reversed to 4 -
		Went back quickly at first, and then slowly recovered to 12.5 + in 45 seconds.
12.5 +	1 minute.	Reversed to 8 -
		Went back instantly to 3.5 +, recovering slowly to 12.5 in 70 seconds.
12.5 +	2 minutes.	Same as 1 minute.
12.5 +	3 minutes.	Same as 1 minute.

The same effects were produced with the experimental arm. With only one insulator, reversed, the cup being full of water and the surface well wetted, a deflection was got of 4 degrees, equal to .0027 milliamperes. When the current from this insulator was reduced to 2 + through the surface drying, a reversal could always be obtained to 4 -, and sometimes to 6 -, by charging it from 90 volts -.

During the capacity tests already mentioned, it was observed that for some time after the commencement of rain, the apparent capacity of the wire invariably rose, instead of falling with the decrease of insulation. This effect has, of course, been noticed before, but, as the author was not aware that it had been satisfactorily accounted for, it was resolved to investigate, and the result of the investigation seems to point to several contributory causes. Firstly, no doubt, the line current due to the voltaic action already described will increase or diminish the discharge according to the direction of the charging current. Secondly, the polarisation of the bolts due to the charging current will have the same tendency. But the capacity of the line will appear too high when the moisture on the insulators is too slight to permit of voltaic action. To seek the cause of this, 12 feet of copper wire was run on six dry insulators fixed in oaken arms in the test room. With 90 volts the wire gave a discharge of .4 degree. The tops of the insulators around the binding wire were wiped with a wet sponge. The discharge then rose to 1 degree, more than double. Wetting more of the surface of the insulators resulted in a still further increase. Several discharges could be got without renewing the battery charge. It would, therefore, appear that wetting the insulators is equivalent to an increase of conductor surface. The moisture has to be charged as well as the wire, and the consequent discharge is greater than with a dry wire. The effect is only observable in moderate rain, or for some little time after the commencement of heavy rain, when the insulators become thoroughly wet the insulation and the capacity fall together, and then the voltaic action and polarisation come into play together with another phenomenon which has not yet been referred to.

Incidentally, in the course of these tests, it was found that when a wire is in contact with moist wood, and is charged from a powerful battery (90 volts were used), the discharge is several times stronger than when the same wire is supported on dry or partially moist insulators. Thus a length of wire on insulators gave a discharge of .9 degree; when fastened along an oaken arm not sensibly damp, with staples of the same metal as the wire, the discharge, after 20 seconds charge amounted to 4.5 degrees, and after 80 seconds to 5 degrees. Then a residual charge appeared to remain in the wood, as the wire continued to yield a current of .5 degree for some minutes, then gradually dying away to nothing.

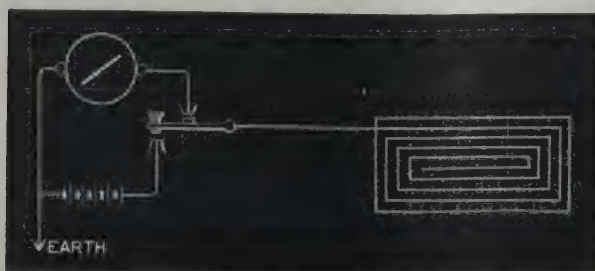


FIG. 6.

Many tests, varied in details, gave the same results; 30 feet of wire in air gave a discharge of .4 degree. When the same wire was stapled on a deal board (fig. 6) not sensibly damp, the discharge became 3.5 degrees, falling immediately to 1 degree, and

then slowly to zero. The wire and the wood were then sponged and the discharge rose to 7 degrees, falling immediately to 2 degrees, and returning slowly to zero. The wire yielded a series of smaller discharges for several minutes without any fresh contact with the battery. A deal box wetted, having some bronze wire in contact with it, was well insulated by being suspended by G.P. Charged for 20 seconds from 90 volts, it gave a discharge of 1.6 degrees, sinking immediately to .8 degree, and then gradually to zero. The same box standing on the floor, gave a discharge, under the same conditions, of 12 degrees, sinking to 3 degrees, and then slowly to zero. The same box touched by the end of an earth wire—also of bronze—well away from the bronze wire, gave a discharge of 45 degrees, sinking immediately to 26 degrees, and thereafter slowly to zero. In the two first cases only one metallic conductor, that is to say, the bronze, through which the charge was communicated, was present, and the source of the return current is not very apparent.

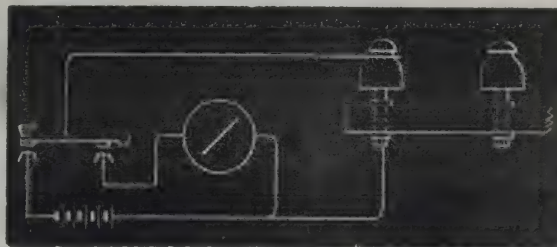


FIG. 7. A.

The last case closely resembles a wet telegraph pole, the earth wire of which does not touch the bolts. Then an expanse of wet wood intervenes between the bolts and the earth, and a powerful charging current in the line must, with leaky insulators, result in back currents. As it is evident that moisture in wood has the effect of increasing the capacity, it may not be unreasonable to deduce that moisture in the air surrounding the wire may have the same effect.

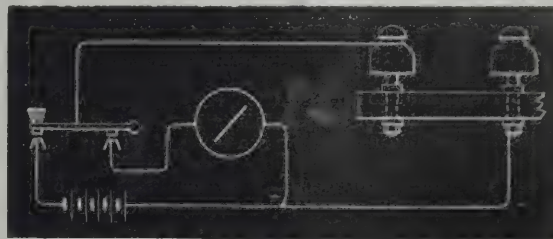


FIG. 7. B.

The foregoing particulars apply whether the line is of copper or of iron; the following observation applies to iron alone.

It has been mentioned that no current between a galvanised iron wire on a wet insulator and the bolt could be detected. But if such a wire is charged by 90 volts, the discharge is followed by

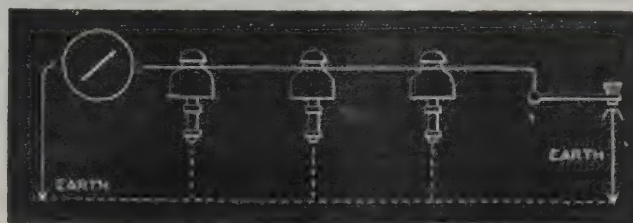


FIG. 8.

a counter current from the insulator. The effect can be produced with a few inches of galvanised iron wire and a wet insulator. As in A, fig. 7. Charging such an arrangement by 90 volts yielded a discharge of .4 degree and a counter current of .3 degree, which did not wholly disappear for some three minutes. Obviously, the polarisation of the bolt following on electrolysis of the moisture made the insulator a secondary battery. The effect of damp wood may be markedly shown by shifting the return wire to the bolt of an adjoining insulator as in B, fig. 7. The discharge then became 1.5 degrees, and the counter current 1 degree, an augmentation of nearly four times.

Connecting the earth wire direct to the bolts will obviate the effect of moist wood, but it increases the strength of the voltaic action and the polarisation of bolts by the charging current.

Although the Americans escape the voltaic action consequent on the use of metallic bolts, the damp wood of their poles cannot be without its effect in wet weather with the insulators they use.

The current set up between copper wire and iron bolts in wet weather might be used to signal with. The experiment has not been tried, but it seems plain that a galvanometer at A, fig. 8.\*

\* There is no lettering on the drawing sent to us.—Eds. ELKO. REV.

through which the line current circulates in its full strength when the wire is insulated at B, would be affected by the working of a key between the line and earth at B, for the key, when closed, would shunt a large proportion of the current away from the galvanometer.

It will be observed that these experiments were made with the distant ends insulated, a condition which does not obtain in ordinary telegraphy. The practical effect of the disturbances noted may be insignificant, especially with double current working, but still it is well to know that they exist.

*Note.*—Since reading the paper it has occurred to the author that the probability of this conclusion—that aimed at in paragraph commencing “The last case closely resembles”—is strengthened by considering that dry and moist air have very different capacities for heat. Tyndall found that the absorption of heat by dry air being 1, that of the air of his laboratory, not specially damp, was 72, while that of air designedly moistened was no less than 90. Thermal and electrical vibrations differ only in frequency, so that some common absorptive action in respect to air may be looked for. The heat absorbed by the moisture in the air is, after the withdrawal of the source of heat, radiated or discharged, not instantly, but gradually, just as the electrical charge, after the cutting off of the battery, is parted with slowly and by degrees, as indicated by the residual charge. It may be expected, therefore, that the apparent capacity of a conductor will be least when contained in artificially dried air.

“The Working Efficiency of Secondary Cells.” By W. E. AYRTON; C. G. LAMB, E. W. SMITH and M. W. WOODS, Associates. Read at Edinburgh, Wednesday, July 16th.

(Continued from page 82.)

#### VI.—RESULTS OBTAINED WITH AUTOMATIC APPARATUS.

Many preliminary experiments having been made with the automatic apparatus, we succeeded in making it work quite satisfactorily by the beginning of May, 1889, and it was adjusted to charge five accumulators, A (fig. 5), with a steady current of 9 amperes until the P.D. reached 2.4 volts per cell, and to discharge them with a steady current of 10 amperes until the P.D. fell to 1.6 volts per cell. After 12 days and nights had been spent in continuous charging and discharging, the cells reached a normal state, the time rise of P.D. in charging and the time fall in discharging being at length repeated over and over again, so that when the time curves were drawn for the successive charges they exactly coincided, and so for the discharge curves. The areas of these curves—reckoned, of course, from the zero of P.D., which is much below the figure as here shown—may thus be said to give the “working watt-hours” for charge and for discharge when the charge and discharge are effected between limits of 1.6 and 2.4 volts per cell. Fig. 6 shows the discharge curves obtained on May 16th, 17th, 18th and 19th, the points for each of the discharges being indicated by points differently marked as stated on the figure; and fig. 7 shows the intermediate charge curves obtained on May 17th, 18th, and 19th. Integrating these curves, we find—

Discharge.		Charge.		Percentage Working efficiency.	
Ampere-hours.	Watt-hours per cell.	Ampere-hours.	Watt-hours per cell.	Quantity.	Energy.
115	221.8	117	256.2	98.3	86.5

Soon after this very concordant set of results was obtained, the time of charging, which had remained steadily at 13 hours from the commencement of May, began to increase to 15½ hours, while the time of discharge only increased half an hour—that is, to about 12 hours. At first we thought that we had been trying to charge the cells too much, so we stopped the charging when the P.D. per cell rose to 2.35 volts; but the time of charging still continued to increase, until at last it rose to 24 hours, the time of discharge still remaining about 12 hours. On again reducing the P.D. limit on charging, the P.D. per cell now refusing to rise to 2.35 volts, both the times of charging and discharging became very irregular, and at length the time of charging suddenly fell to 10 hours and the time of discharging to 6. On carefully examining the plates, they were found to have badly scaled, and to have suddenly become partially short-circuited; they were therefore carefully scraped, and the mud allowed to settle at the bottom, where, in consequence of the special construction of the 1888 cell, it could remain without short-circuiting the plates. Only a few plugs fell out in this operation. This sediment was afterwards weighed and analysed, showing a composition that will be referred to in Section VIII., on the chemical action.

We now concluded that we had been running the cells too low, and we therefore decided to stop the discharge when the P.D. per cell fell to 1.8 volts, retaining the higher limit of 2.4 volts per cell to limit the charge. It is interesting to notice that Dr. Louis Duncan and Mr. H. Wiegand, in their paper on “The Inherent Defects of Lead Batteries,” read before the American Institute of Electrical Engineers, and which we saw for the first time at the end of June, 1889, reprinted in the *Electrical World*, come to exactly the same conclusion—that the discharge should be terminated at 1.8 volts per cell, otherwise there is a formation of white

lead sulphate and a rapid depreciation of the cell. From what we have since seen, we think that the discharge should be stopped even still sooner—when the P.D. per cell has reached 1.9, or 1.85 volts at the lowest.

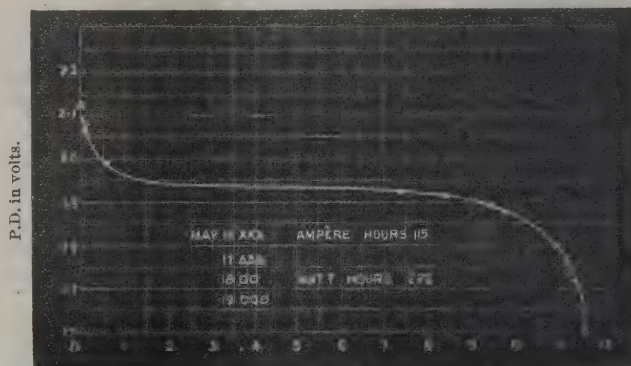
We therefore adjusted the automatic interruptor to stop the discharge when the P.D. per cell was 1.8 volts, and the immediate result of this was to bring the time of charging up to 12½ hours, and to bring up the time of discharging to 10½ hours. After continuing the charging and discharging continuously day and night for 13 days, the cells reached a perfectly steady state. Curve 8 shows the time fall of P.D. per cell in the discharges finished in the early morning of June 19th, recommenced in the night of June 19th, and again commenced late on June 20th, all the three discharges being so precisely similar that they can be represented by one curve; and, similarly, curve 9 shows the intermediate chargings on June 18th, 19th, and 20th, which were also exactly like one another. The times of the three discharges and of the three charges were, respectively, in hours and minutes—

#### TIMES OF SUCCESSIVE

Discharges.	Charges.
10 h. 10 m.	11 h. 38 m.
10 h. 10 m.	11 h. 37 m.
10 h. 11 m.	11 h. 37 m.

showing to what an absolutely definite state cells arrive after a definite cycle of charge and discharge between fixed limits has been repeated continuously without interruption for some weeks.

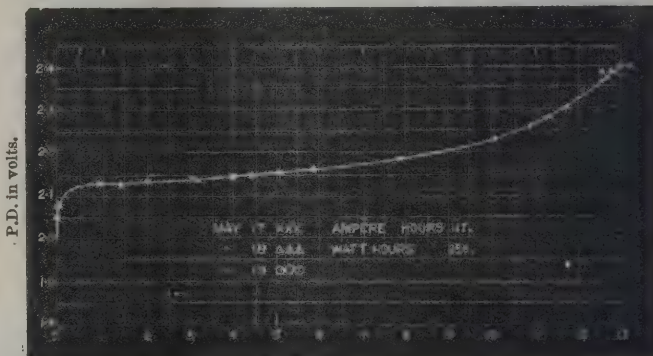
Working potential difference per cell, discharging with 10 amperes.



Time in hours from beginning of discharge.

FIG. 6.

Working potential difference per cell, charging with 9 amperes.



Time in hours from beginning of charge.

FIG. 7.

Integrating these curves, we find—

Discharge.		Charge.		Percentage working efficiency.	
Ampere-hours.	Watt-hours per cell.	Ampere-hours.	Watt-hours per cell.	Quantity.	Energy.
101.9	201.7	104.5	230.7	97.2	87.4

The numbers contained in this last table may probably be considered as giving the steady working values for this size and type of cell. 230.7 watt-hours are equivalent to 612,200 foot-lbs., and as the positive and negative plates of one cell weigh 28 lbs. 10 oz., the working storage capacity is 21,380 foot-lbs. per lb. of plate.

#### VII.—EFFECT OF REST.

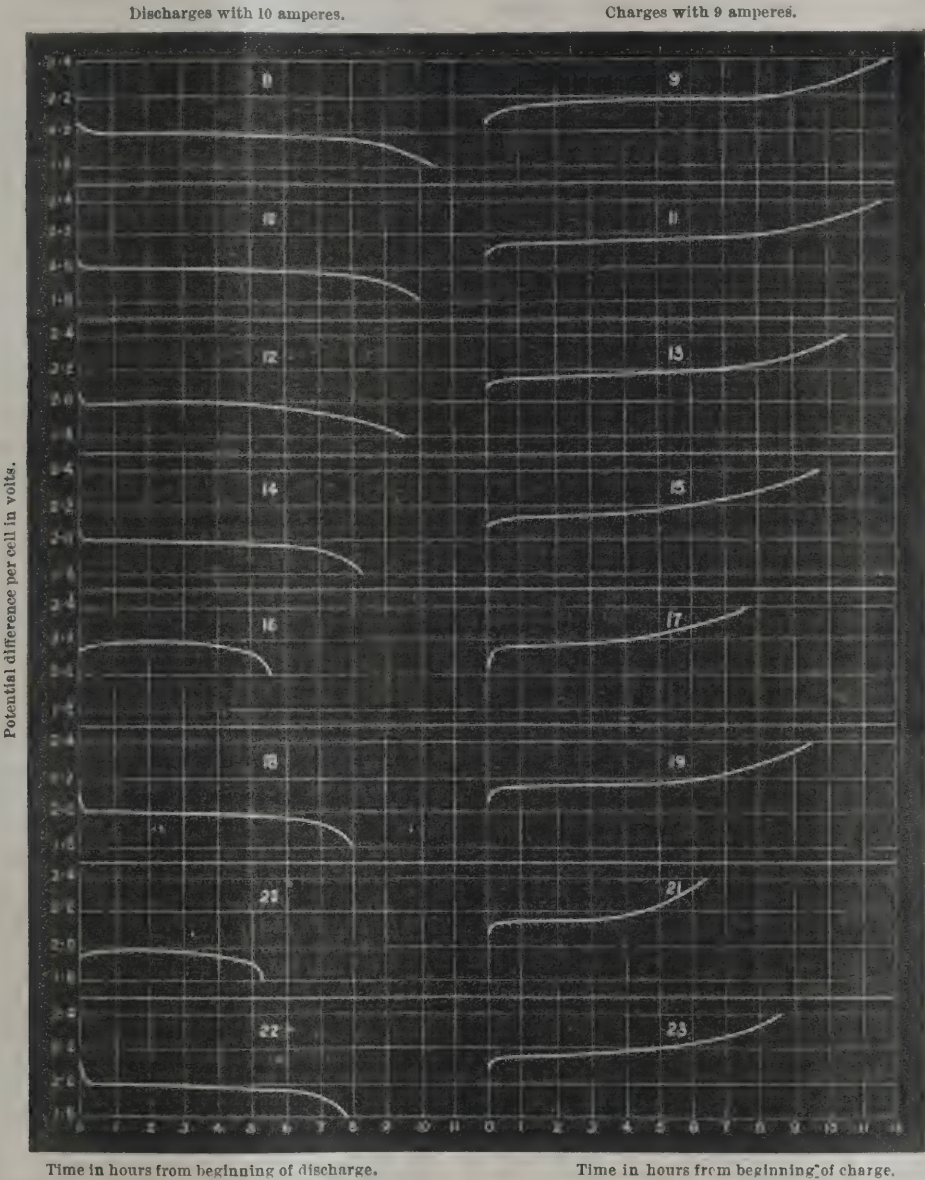
We next tried the effect produced on the capacity and efficiency of accumulators by prolonged rests. The five cells used in the experiments stood on porcelain insulators containing resin oil; and as the insulators, which were specially made for the Central

Institution, were taller than those commonly employed to support accumulators, and as all connecting wires were removed from the cells while they were allowed to rest, it is certain that any change in the cells must have been caused by internal action, and could not have been due to external leakage.

The cells, having been fully charged on June 22nd, were allowed to rest, insulated as above described, until July 2nd—that is, for 10 days. The first few curves of discharge and charge after the rest showed a considerable diminution in capacity and efficiency; but after one week's continuous charging day and night a steady cycle was reached, the following being the times of successive discharges and charges, the limiting P.D.'s, as before, being 1·8 and 2·4 volts :—

August 1st. The first discharge at the end of the rest gave a quantity efficiency of only 80 per cent., so that 20 per cent. of the charge was lost. After a week's continued charging and discharging between the former limits of volts, the cells regained a steady state, but the time of charge and of discharge is now less than before this second rest. The times after the week's charging and discharging were—

Discharges.	Charges.
9 h. 3 m.	10 h. 41 m.
9 h. 2 m.	10 h. 44 m.
9 h. 10 m.	10 h. 51 m.



TIMES OF SUCCESSIVE	
Discharges.	Charges.
10 h. 1 m.	11 h. 35 m.
9 h. 59 m.	11 h. 30 m.
9 h. 58 m.	11 h. 32 m.
9 h. 57 m.	11 h. 33 m.

Curves 10 and 11 show the variation of the P.D. per cell, and on integrating these curves we obtain—

Discharge.		Charge.		Percentage working efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
100	198	103·8	228·2	96·4	85·8

Rest, then, of an accumulator, although left well insulated and fully charged at the commencement, alters the accumulator so that for the first few charges and discharges after the rest it is a much less valuable instrument than before. A week's continuous charging and discharging day and night, however, removes this effect to a great extent; the efficiency, however, still remains somewhat lower than before the rest.

Next, the cells were allowed to rest charged for 12 days, until

Curves 12 and 13 show the P.D. curves when the cells had acquired a steady state, and on integrating them we find—

Discharge.		Charge.		Percentage working efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
91	176·7	96·8	213·2	94·1	82·8

We see, then, that a week's continuous charging and discharging of these cells is unable to compensate for the harm produced by their being left for 12 days fully charged. The two rests of 10 days and 12 days respectively, although followed in each case by a week's continuous charging and discharging, have reduced the discharge ampère-hours by 10 per cent., the discharge watt-hours by 12 per cent., the quantity efficiency by 3 per cent., and the energy efficiency by 5 per cent.

Third Rest.—The cells having been fully charged, a third rest of 16 days took place. On the first discharge, at the normal rate of 10 amperes, the ampère-hours were only 75. After, however, the charging and discharging at the normal rates had been continued for three days and nights, the times of discharging and charging became steady.

TIMES OF SUCCESSIVE

Discharges.	Charges.
8 h. 12 m.	9 h. 28 m.
8 h. 17 m.	9 h. 35 m.
8 h. 19 m.	9 h. 35 m.

and curves 14 and 15 show the working values of the P.D. in discharging and charging. Integrating the curves, we obtain—

Discharge.		Charge.		Percentage working efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
82.6	161.3	86.2	190.5	95.8	84.7

*Fourth Rest.*—The cells, having been fully charged, were allowed to rest for 16 days. Curve 16 gives the values of P.D. obtained at the first discharge, and curve 17 the values of the P.D. obtained immediately afterwards in charging. Integrating the former curve, and comparing its area with the area of the charge curve (15) obtained just before the rest, we find—

First discharge after rest.		Last charge before rest.		Percentage efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
56.5	110.5	86.2	190.5	65.5	58

If, however, we compare the result of the first discharge after the rest with the first subsequent charge, shown in curve 17, we find—

First discharge after rest.		First charge after rest.		Percentage efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
56.5	110.5	71.1	158.3	79.6	69.6

The cells were now continuously, without intermission, charged with the normal current of 9 ampères, and discharged with 10; the discharge, as before, being automatically stopped when the P.D. per cell had fallen to 1.8 volts, and the charge when it had risen to 2.4 volts. The following give the successive times in hours and minutes in which the cycles were completed :—

First discharge after rest 5 h. 40 m.	First charge, 7 h. 54 m.
Second „ „ 7 h. 6 m.	Second „ 8 h. 30 m.
Third „ „ 7 h. 31 m.	Third „ 8 h. 51 m.
Fourth „ „ 7 h. 29 m.	Fourth „ 8 h. 52 m.
Fifth „ „ 7 h. 43 m.	Fifth „ 9 h. 17 m.
Sixth „ „ 8 h. 0 m.	Sixth „ 9 h. 24 m.
Seventh „ „ 8 h. 5 m.	Seventh „ 9 h. 17 m.
Eighth „ „ 7 h. 57 m.	Eighth „ 9 h. 20 m.

From the last three discharges and charges we see that the cells have arrived at a steady state, and curves 18 and 19 show the steady, or working, values of the P.D. for these three discharges and charges. Integrating the areas of these two sets of curves, we find—

Discharge.		Charge.		Percentage working efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
80	156.9	83.8	184.6	95.5	85

*Fifth Rest.*—The cells were now left charged for a further period of 16 days. Curve 20 gives the values of the P.D. obtained at the first discharge after the rest, and curve 21 the values of the P.D. obtained immediately afterwards in charging. Integrating the areas of these curves, we have—

First discharge after rest.		Last discharge before rest.		Percentage efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
53.3	104.1	83.8	184.6	63.6	56.4
		First charge after rest.			
		58.5	128.3	91.1	81.1

Continuous charging and discharging with the normal currents between the normal limits of P.D. per cell gave the following times for completing the cycles :—

First discharge after rest 5 h. 20 m.	First charge, 6 h. 30 m.
Second „ „ 6 h. 18 m.	Second „ 7 h. 29 m.
Third „ „ 6 h. 42 m.	Third „ 7 h. 59 m.
Fourth „ „ 6 h. 54 m.	Fourth „ 8 h. 19 m.
Fifth „ „ 7 h. 15 m.	Fifth „ 8 h. 20 m.
Sixth „ „ 7 h. 16 m.	Sixth „ 8 h. 30 m.
Seventh „ „ 7 h. 23 m.	Seventh „ 8 h. 41 m.
Eighth „ „ 7 h. 34 m.	Eighth „ 8 h. 44 m.
Ninth „ „ 7 h. 40 m.	Ninth „ 8 h. 47 m.

It was concluded from the times of the last three charges and discharges that the cells had acquired a steady state, and curves 22 and 23 show the time fall and the time rise of P.D. Integrating the areas of these curves, we have—

Discharge.		Charge.		Percentage working efficiency.	
Ampère-hours.	Watt-hours per cell.	Ampère-hours.	Watt-hours per cell.	Quantity.	Energy.
76	149.5	78.3	173.2	97.1	86.3

(To be continued.)

LEGAL.

**Stanley and Davies v. Milner and Co.**—This case came on for hearing at Manchester last week before Mr. Justice VAUGHAN WILLIAMS and a Common Jury.—The plaintiffs, who are engaged in business as electrical engineers, sought to recover from the defendants, who are bleachers and finishers at Pendlebury, £136 for goods sold and work done. Mr. Fleming appeared for the plaintiffs, and the defendants were represented by Mr. Yates. Counsel for the plaintiffs stated that, on the 6th of June, 1889, negotiations were commenced between the parties for the lighting of the defendants' works by electricity. On the 7th of August, a contract was made by the plaintiffs to do the necessary work. An installation consisting of 46 lamps was accordingly placed in the works, and the illumination was so complete that Mr. Milner expressed himself satisfied with it. When the plaintiffs' men had left the works, complaints were made by the defendants to the effect that the installation was working improperly. The plaintiffs went to see what was the matter, and made the necessary repairs. They, however, found that a man was in charge of the installation who knew nothing about it, and that the defendants' workpeople did not take due care of the machinery for producing the electricity. Under those circumstances it was natural that the installation should go wrong. The plaintiffs repaired a number of lamps which appeared to have been broken by negligent means, but eventually refused to undertake further supervision of the plant unless they received a proper order from the defendants. The installation only consisted of 46 lamps, and of these not more than eight had been the subject of complaint. The defendants had pleaded that the whole installation was useless to them, and refused to pay the amount claimed by the plaintiffs, with the exception of £42 10s., the price of an engine, which amount they had paid into court. Mr. Thomas Stanley, one of the plaintiffs, gave evidence bearing out the statement of counsel. In answer to Mr. Yates, he said that if acid vapours floated about the works and got inside the lamp holders they would corrode the metal. All the main branch wires were cased with wood, and he contended that the wires were fit for electric lighting purposes. He was not aware that electricity escaped to such an extent that no fire office would insure the works.

Other witnesses were called for the plaintiffs, whose evidence went to show that the installation worked satisfactorily when completed. The machinery, however, was not duly cared for, and the result was that after the plaintiffs had left the works the

plant began to work irregularly. Some of the wires also became corroded, owing to the acidulous vapours that floated about the works.

Counsel for the defence submitted that the contract with the plaintiffs was to fit a bleachworks with an electric installation—"the wire to be of the best insulation, and of the highest conductivity of copper." The work was to be done in the best possible manner, and to be fit for a bleachworks. It was admitted in the plaintiffs' case that the wire inserted was not "of the best insulation and the highest conductivity of copper." That was a material point, because the fact that corrosion ensued showed that the material could not have been of the highest kind, or that it was fitted in the best possible manner.

The JUDGE said that, on the contract as it stood, it was extremely doubtful whether the sellers of the machinery contracted to supply machinery suitable with reference to the peculiarities of bleachworks. The whole question of the case was whether the plaintiffs were bound to supply machinery suitable with reference to the peculiarities of bleachworks. He should ask the jury whether the machinery supplied was fitted for bleachworks generally. It was really common ground, and it was tolerably clear that the failure of the machinery was due to corrosion of the wires and holders, in consequence of the presence of steam and acidulous vapours. The whole question of the case was whether the plaintiffs were bound to supply machinery which should afford protection against these vapours.

Mr. H. MILNER, one of the defendants, said the process of bleaching carried on by the defendants was the ordinary one. The installation by the plaintiffs never worked satisfactorily, and occasionally paraffin lamps had to be resorted to.

Mr. E. W. COWAN, an electrical consulting engineer, said he had examined the electrical machinery at the defendants' works. The failure of the plant was due to corrosion of the fuse wire. The wire laid was not of "the best insulation and highest conductivity of copper." The corrosion of the fuse wire caused a leakage of electricity, and the firm in that case ran a risk of fire.

Mr. FAWCUS, manager for the Edison and Swan Company, considered the wire not only unfit for bleach-works, but altogether unsuitable for electric lighting.

The JUDGE said he proposed to ask the jury the following questions:—(1) Was the machinery delivered according to contract, apart from its suitability for user in bleachworks? (2) Was the machinery delivered according to contract, assuming that the plaintiffs contracted to supply machinery suitable for user in bleachworks? (3) Was the machinery wholly useless, or only defective? If only defective, at what sum did they assess the defect?

Mr. YATES said he thought it was assumed that the machinery was useless, otherwise he should have asked the two scientific gentlemen he had called whether it was absolutely bad.

Mr. FLEMING said the plaintiffs only complained of eight lamps out of 46 being defective.

The JUDGE remarked Mr. Yates was at liberty to recall one of his witnesses.

Mr. FAWCUS (re-examined) said he should not like to say that the machinery was useless, or to put any value upon it.

The JUDGE: What would be the most prudent thing for a man to do with that installation in your opinion? Would you take it out and get a new one, or alter it so as to get rid of the present defects?

Mr. FAWCUS: I should certainly take it out and get a new one. The present dynamo might be used again, but new wiring is absolutely essential.

Mr. FLEMING having addressed the jury on the evidence, The JUDGE summed up.

After a brief absence, the jury returned a verdict for the plaintiffs for the amount claimed, and judgment was entered accordingly.

**International Cable Company.**—The petition for the winding up of this company, which has been before the Court on several occasions, was resumed before Mr. Justice Stirling.

Mr. HASTINGS, Q.C. (with him Mr. Grosvenor Woods), said the petition was presented by a contributor upon the ground that the substratum of the company was gone, and after the case had been very fully argued in May last, his lordship came to the conclusion that it was not absolutely certain that the Portuguese concession, which was the substratum of the company, was gone, more especially as it was suggested that the Portuguese Government might have revived it, and accordingly directed the petition to stand over until to-day. An affidavit had been made by Mr. Rochs and Sir Alexander Armstrong on behalf of the company, but from this affidavit it was clear that the substratum was gone, and that there was no more chance of the concession being got now than there was of a gold mine being got by the company. What these gentlemen stated was this—that Senor Carilho, who seemed to be very friendly with everybody, including the Portuguese Government, had a great chance of getting a new concession between Lisbon and the Azores, and they also thought it was extremely probable that if he got it he would be ready to part with it to the company for a very moderate sum of money, and they were also sanguine that the necessary capital would be subscribed. Therefore, this affidavit clearly proved that the old concession was gone, and that the capital was absolutely insufficient for working either the old or new concession. Under these circumstances, he submitted that the petitioner was entitled to a winding up order.

The further hearing was adjourned until to-morrow.

## NEW PATENTS—1890.

10508. "Improvements in electrical railways and tramways." J. HOPKINSON. Dated July 7.

10515. "An improved connector for the electrodes and cells of primary and secondary electrical batteries." A. J. JARMAN. Dated July 7. (Complete.)

10527. "Improvements in magneto-voltaic and static electrodes." E. S. D'ODIARDI and A. THOMPSON. Dated July 8.

10528. "Improvements in electric atomizers." E. S. D'ODIARDI and A. THOMPSON. Dated July 8.

10529. "Improvements in pneumo-dynamometers." E. S. D'ODIARDI and A. THOMPSON. Dated July 8.

10530. "Improvements in liquid electrodes." E. S. D'ODIARDI and A. THOMPSON. Dated July 8.

10531. "Improvements in the healing electric static cup." E. S. D'ODIARDI and A. THOMPSON. Dated July 8.

10532. "Improvements in electro-inhalers." E. S. D'ODIARDI and A. THOMPSON. Dated July 8.

10577. "Improvements in automatic electric fire alarm systems." P. JENSEN. (Communicated by the European Fire Service and Motor Co., United States.) Dated July 8. (Complete.)

10587. "Improvements in electric switch apparatus." P. KNOCH and M. PFEIFFER. Dated July 8.

10593. "Improvements in electric motor apparatus." S. C. C. CURRIE. Dated July 8. (Complete.)

19595. "Improvements in apparatus for measuring electrical energy." E. THOMSON. Dated July 8. (Complete.)

10640. "Improvements in sash fastenings and sash latch locks, and electric bell contact alarm, burglary preventer and detector." W. W. WILLMOTH. Dated July 9.

10646. "Improvements in apparatus for automatically controlling or maintaining electric circuits." M. H. KILGOUR. Dated July 9.

10712. "Improvements in electric lamp couplers or holders." A. E. NICHOLS. Dated July 10. (Complete.)

10714. "Improvements in and connected with electrical apparatus for recording the presence of watchmen, workmen, or others." W. LUCAS and T. A. GARRETT. Dated July 10.

10736. "Improvements in electric lamps for medical and surgical purposes." M. P. OUDIN and H. O. KRATZ-BOUSSAC. Dated July 10.

10740. "Improvements in incandescence bodies for electric glow lamps." SIEMENS BROTHERS & Co. (Communicated by Siemens and Halske, Germany.) Dated July 10.

10741. "Improvements in incandescence bodies for electric glow lamps." SIEMENS BROTHERS & Co. (Communicated by Siemens & Halske, Germany.) Dated July 10.

10742. "Improvements in incandescence bodies for electric glow lamps." SIEMENS BROTHERS & Co. (Communicated by Siemens and Halske, Germany.) Dated July 10.

10743. "Improvements in the means for effecting conducting connection between overhead conductors on electrical railways and tramways and the electrical apparatus on the vehicles." SIEMENS BROTHERS & Co. (Communicated by Siemens & Halske, Germany.) Dated July 10.

10765. "Improvements in means or devices for detecting electrical inductive effects." A. W. HEAVISIDE and E. C. JACKSON. Dated July 11.

10792. "A new or improved combined door knocker and electric bell." F. WILCOCKS. Dated July 11.

10801. "Automatic clock work apparatus for effecting cooking operations, the lighting of fires, and the like, also applicable for giving electric signals." J. J. GILBERT. Dated July 11.

10805. "Improvements in methods and apparatus for applying the power of electric motors, especially applicable to electric railways." B. J. B. MILLS. (Communicated by T. A. Edison, United States.) Dated July 11.

10806. "Improved underground conduit system for electrical distribution." B. J. B. MILLS. (Communicated by E. T. Greenfield, United States.) Dated July 11.

10857. "Improvements in metallic coverings for electric wires." J. M. MUNRO. Dated July 11.

10868. "Improvements in electricity meters." E. DE PASS. (Communicated by E. Marès, France.) Dated July 13. (Complete.)

10900. "An improved electric switch alarm." C. VANDERBILT. Dated July 12.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889

6875. "An improved construction and mounting of the spring armature and hammer for electric bells and other like electrical instruments." J. C. WILLIAMSON. Dated April 24. 8d. Consists in mounting the armature on a spring (straight or curved) which may be of steel, brass, or other suitable metal, and which at its free end carries the hammer for an electric bell. 5 claims.

8958. "An electric meter." A. FRAGER. Dated May 29. 11d. Relates to an electric meter consisting of three principal parts or organs:—(1) an electro-dynamometer, which at every instant indicates the electric energy expended per second; (2) a clockwork which indicates the time during which the energy is expended; (3) a counter which registers the product of energy by time on suitable dials. 6 claims.

20261. "Improvements in electric semaphores for railways." F. STITZEL, C. WEINDEL, A. REUTLINGER, M. J. SCHWARTZ, J. H. EGGELHOFF, and J. KREIGER, all of the City of Louisville. Dated December 17. 8d. Has for its object to produce a semaphore which shall be sure and effective in operation. A further object is to so construct the apparatus that but little battery power will be required to operate it. A further object is to so construct a semaphore apparatus that when set the rattling of the parts caused by the jar of a passing train will not operate to release the mechanism. A further object is to construct a semaphore device in which some of the parts make contact with other parts with more or less pressure, so that when it is desired to release said parts one of them will be positively pushed from the other. A further object is to produce a signalling device actuated and controlled by the combined force of weights and electricity, and which shall be compact in construction and sensitive in operation. 14 claims.

20400. "Improvements in apparatus for obtaining a record of the movements of indicators by means of electricity." T. J. MURDAY. Dated December 18. 8d. Has for his object improvements in apparatus for obtaining, by means of electricity, a continuous record from a distance of the indications or movements of instruments or indicators, such as steam pressure gauges, anemometers, aneroid barometers and the like, which are provided with an index or pointer moving over a scale. 1 claim.

20911. "Improved battery plates for storage batteries." A. E. WOOLF. Dated December 31. 8d. Relates to particular methods of constructing the plates. 9 claims.

20971. "An electric exercising machine." O. IMRAY. (Communicated from abroad by the Electric Exercising Machine Company of America. Dated December 31. 8d. Relates to an exercising machine by which when used electric currents are conveyed through the body of the user, thereby obtaining simultaneously the therapeutic effects of the bodily exercise and the application of electricity. 10 claims.

## CORRESPONDENCE.

### Fire Office Rules.

In reply to Mr. J. B. Verity's letter in your last issue, asking what is to be done to meet the various requirements of the insurance companies, I should like to suggest that the best way to avoid trouble is to carry out all installations in accordance with the Phoenix Fire Office Rules, which are so well known and understood.

I do not think that any other office would object to work, if carried out in this way, as it is well known that the Phoenix rules are the most complete and also the strictest. Surely they cover all other rules, though the latter do in many cases differ, inasmuch as they are more lenient and often do not ask for such good material as the Phoenix, but I do not think an inspector would object on that score. I always carry out my contracts in this way, quite regardless whether Mr. Heaphy will inspect the work, or any other surveyor, and have never experienced any difficulties with the other offices.

It is, of course, a great misfortune that there is not a standard set of rules for contractors to work to, as endless trouble might thus be saved. I think the rules of the Institution of Electrical Engineers would have to be considerably revised before they could be accepted as a standard.

F. Geere How d.

July 20th, 1890.

### Electric Traction.

Having read an article in your REVIEW concerning myself, I shall be obliged by your permission to say a few words in reply.

You say that my work will be published in a few weeks' time. You would have been more exact had

you said that it had already been published at length in *La Lumière Electrique*, and that almost simultaneously a translation had appeared in the New York *Electrical World*. It has, in fact, been published in Brussels and Madrid as well.

Regarding my method, which I prefer (for Paris, be it understood) to the self-contained car and the electric locomotive, you quote the objections raised by a Parisian journal, that "it would present difficulties in practice owing to the length of the coach." The objection might as well have been taken to the horses, by which the length of the coach is increased some 4 metres, whereas my arrangement would only increase it by 2 metres or 2 m. 50.

You say it is a pity that my scheme is based upon estimates and not upon facts: allow me to disagree with you there.

In devising a practical scheme, which has no present existence (such as electric traction applied to the tramways of the General Omnibus Company of Paris), we are bound to make a forecast of the probable expense, and a detailed estimate of this sort can very well be made upon facts which have a separate existence elsewhere; and the exactness of the entire estimate may be perfect although all the details have as yet not been combined in a single scheme.

Thus if, for example, I estimate the salary of the head of a dépôt at 4,800 frs., that of an overseer at 3,600 frs., that of a workman at 1,800 &c., it is because we consequently meet with persons filling these offices on such salaries.

If I estimate the cost of a steam engine at 0.085 fr. per hour, it is because it is well known that under analogous conditions of power and of work in Paris, that is the average cost.

As regards the cost of plates and accumulators, you will admit that I am in a position to judge; and further, I will agree to deliver them to any amount under the conditions I have named.

You say I have taken no account of the conductors' wages, which is perfectly true, and would be equally true of the innumerable expenses which are incident to animal traction as well as electric traction, and which are of no interest in deciding the simple question of traction, and would be a useless complication of the estimate. What is important is the difference between the cost and the net profit of the two kinds of traction, and expenditure which is common and equal to both alike have no bearing on the question. As regards the gross expenditure, therefore, we need only consider the expenditure on plates and accumulators. Now, I read in the *Revue Industrielle* of the 5th July, an assertion by Mr. Frank Wynne, that in England it is not possible to obtain accumulators for electric traction capable of bearing more than 200 charges. Mr. F. King, on the other hand, mentions 450; whereas my calculation was 180 charges. You will, therefore, admit that there is no absolute agreement even in regard to facts; and that, at any rate, by taking the most unfavourable figure, my conclusions in favour of electric traction are more likely to be correct.

Finally, you challenge me to furnish data from a given line in Paris. If you will only take the trouble to look up the journal I have mentioned, you will see the following: "The service is yet too recent to offer any idea of the cost of maintenance of the accumulators." It would, therefore, be of no use for me to ask for these details.

I shall be obliged by your inserting the above remarks in an early number of the ELECTRICAL REVIEW, and beg to thank you in advance, &c.

Paul Gadot.

### A Correction.

At the commencement of line 10 in my letter last week about lubricating oils, instead of plaintiff company, it should read *defendant* company.

J. C. Richardson.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## THE POSTMASTER-GENERAL AND POST OFFICE MEETINGS.

IN connection with the discussion of the Post Office estimates, an interesting debate was opened up last week in the House of Commons, when a matter largely affecting the liberty of action of all sections of public officials coming under the control of the Postmaster-General was submitted to severe criticism.

Some time ago the Postmaster-General issued, what were termed, new regulations, under which those engaged in the departments under his control might hold public meetings—these regulations were spoken of as being a relaxation of an official order dated 1866.

From the surprise evinced publicly and officially at the discovery of this comparatively ancient document, and its subsequent amendment by the Postmaster-General, there can be but little doubt that thousands of those directly interested had never heard, or even dreamt of, such a regulation. The heads of departments, too, were in precisely the same state of happy ignorance, and the intelligent being who succeeded in resurrecting the almost unknown order of 1866 from some dusty, neglected, and probably all but forgotten official sarcophagus, will feel that he, at all events, deserves well of his Queen and his country.

The obsolescence of this practically unused tool was too palpable, however, to even a Postmaster-General, and though it was put before the Post Office departments in a sort of "this is what it could be" style, the amended order was adopted as the standard by which all future "staff" meetings would be gauged.

We have referred to the order of 1866 as practically unused. No instance has been quoted in which its application has been resorted to. The Postmaster-General, indeed, confessed that, to his surprise, its existence had been ignored; but we go further than this, and say its existence was unknown; and previous events prove this to be true. It cannot be said that it could not have been used in the past twenty years, for there have been several movements in various grades of

the Postal Service, notably, amongst postmen, sorters, sorting clerks, telegraph clerks, and savings bank clerks, and these movements, at all events, extended to as far back as 1872. In 1881 a strong agitation, fully justified by results, and which made its existence felt throughout the country, occurred in the telegraph service. Prof. Fawcett, the Postmaster-General at that time, did not restrict in any way a movement which, we believe we are correct in saying, he regarded, and even spoke of, as constitutional. Whatever was thought of the progress of the events by the higher departmental officials at that time, and, in some instances, their hostility was not disguised, it is a matter beyond dispute that free public meetings were not only general, but recognised as the legitimate channel for gaining public attention, and most people will fail to see why this should not be the case now. In 1881, the order of 1866 was conspicuous by its absence; and even if it still lingered in the minds of a few, which we doubt, it was looked on as obsolete and old-fashioned. Though the Postmaster-General holds strongly that he has acted in an equitable spirit to those under him, still, the questionable advantages conferred by what will be regarded by many as a fair specimen of official tinkering, do not seem to have won the hearts of those who are inclined to go into the subject, and few will be surprised at their non-conversion. At such meetings in future no one is to be present save those in the service—whatever their status may be. This seems to be specially aimed at those public men whose presence is so often a tower of strength to causes in which many of those interested expect and seek an outside stimulus. But this restriction is double edged. If it deprives one side of friends and councillors it does the same to the other. Will the Postmaster-General say, for instance, that the presence of two or three earnest and moderate members of Parliament, or even other public men, at some of the recent meetings in connection with the mismanaged postmen's movement would not have averted the unfortunate catastrophe which unwise and hasty action engendered? Would not their in-

fluence have held in check, for example, what has been aggressive and suicidal zeal on the part of an individual, or individuals, at the head of the Postmen's Union?

The telegraph clerks' movement, too, may afford another case in point. After conducting a series of meetings in 1889, some with the aid of members of Parliament whose moderate and rational councils have always prevailed, and some without, nothing being kept from the public Press, which is surely a reliable medium of information and discussion, they, too, were brought under the provisions of the Postmaster-General's amended order.

To them assuredly the position was most unpleasant, especially after their unfettered experiences of 1881, and it may have been felt that the Postmaster-General's regulations were more irksome than he had any intention of making them.

There can be no doubt that in many quarters this restriction is considered harsh and arbitrary, and though the Postmaster-General repudiates all such intentions we cannot say that, even with the majority of the House of Commons on his side, he has made out a good case; on the contrary, we question the wisdom and expediency of his action.

The Postmaster-General also requires a statement of the business to be discussed at public meetings, and sends an official reporter to take verbatim reports of all speeches and the names of the speakers. A number of meetings have been held under these conditions, and the Postmaster-General professes to be satisfied with the results of his innovation. His satisfaction, we imagine, is scarcely shared by his subordinates.

To a few meetings, indeed, he has not deemed it necessary to send the "official reporter," and the absence of this doubtful advantage has not led to anything more startling than an expression of surprise that the Postmaster-General should have broken his own rule.

The Postmaster-General also urges that he requires true accounts of what is said, so that grievances and complaints of all kinds may be thoroughly understood and properly considered. He may attain these ends by his plan, but we have heard from not a few in various departments that they would be delighted to have the Postmaster-General in person at their meetings, though they object naturally enough to the "official reporter."

This ingenious if not ingenuous explanation would lead many people to imagine that such a thing as a free public press had no existence in these islands, or if it did exist, that its power as an advocate and mediator was practically inert. Happily, its power needs no demonstrating. It is mighty in its fearless trinity of advocacy, mediation, and criticism.

It must be palpable to everyone that in the hands of officials antagonistic to public meetings, public discussion, and public sympathy, the Postmaster-General's regulations are capable of being used in a most despotic and tyrannical manner, under which officialism would become invested with an aggressive as well as a repressive power, a menace to the one side and a danger to the other. Public opinion would remedy these matters,

but this might not be done until individuals had suffered.

On the other hand, under a generous observance of, and a fair adherence to, those constitutional principles which the Postmaster-General has expressed himself so anxious to encourage, little if any sense of a loss of constitutional right would be felt by those who had substantial and practical questions to ventilate.

Nevertheless, the era of such Draconian rules has certainly passed away, and, under the circumstances, many will regret that the order of 1866 was not relegated for ever to that official obscurity under which it had enjoyed the advantages of nearly a quarter of a century's rest and peace, its bare existence apparently unsuspected by quite a number of Her Majesty's Postmasters-General.

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#### Fire Rules and Regulations.

WE are sadly in want of a set of standard rules for fire risks which would prove acceptable both to insurance offices and electrical contractors. As neither the Phoenix rules nor those compiled by the Institution of Electrical Engineers satisfy the requirements, much uncertainty and considerable annoyance, to contractors particularly, result. Not long since a firm of electrical engineers notified to a fire office that a certain installation was about to be fitted up, and a request was also made for the office to inspect, if it was thought desirable, insurance being effected also with another company. In reply, a letter was received from the inspector, asking for particulars, samples of leads, and enquiring whether the work was being carried out in accordance with the rules of his office. The contractors sent the conductor specimens, and an intimation that the installation had been carried out in the usual manner. They did not wish to commit themselves to any given rules, lest anything occurred afterwards by which they, through a technical objection easily raised on behalf of the fire office, might be held liable. The next episode in this little comedy of errors was the receipt of a letter by the contractors which their own client had received from the fire-office. To their surprise the document commenced by informing the recipient that in consequence of the numerous fires from electricity that have occurred, and the liability of electricity to suddenly cause fire without the least warning in any part of the house where the conductors run, it would be readily understood that the fire office was particularly desirous of ascertaining what precautions had been adopted against danger. Moreover, it was stated that the only reason for troubling the gentleman to whom it was addressed was because the contractors had refused to give any information as to the manner in which the installation was carried out, an assertion which, on the face of the correspondence was, to put it mildly, a perversion of the truth. What the upshot of the business is we do not know, but the incident shows clearly that there is considerable friction between fire offices and contractors, and the sooner they can transact their mutual affairs on a basis suitable to both so much the better for the consumers of electrical energy, who do not desire to be troubled with the quarrels of those whom they engage to supply them. Furthermore, when a fire office asserts that there have been numerous fires from the use of the electric light, and that there is a liability to this

danger at any time and without warning, it becomes desirable in the public interest that these facts should be known without delay. Captain Shaw recently reported that the fires in London from electric lighting amounted to three only during the years 1888 and 1889. Either he is right and the fire office wrong, or there must have been many conflagrations from this cause in the provinces, of which we have never heard. However this may be, we think electrical contractors might with advantage agitate for a set of rules which would enable them to carry out their work on some tangible basis, and steer them clear of the whims or caprices of inspectors, who are too often in antagonism with each other's regulations.

Gas Works and Electric Lighting.

IN the REVIEW for July 11th we published an abstract of a paper, read by Mr. Arthur F. Guy, entitled "Shall Gas Undertakings supply Electricity? Yes." Mr. Guy, who seems to be a very young man, and was probably carried away by the enthusiasm of youth, argued that gas companies were favourably situated in all respects for undertaking the supply of electrical energy; but a perusal of the remarks made by Mr. Stewart, the President of the North British Association of Gas Managers, entirely dissipates this idea. That the latter gives the correct view of the situation is certain, but it would be interesting to our readers to see how Mr. Guy proposes to combat the matured reasoning of his more experienced antagonist.

Improvements in Arc Lamps.

IN our issue of March 14th we commented somewhat strongly on the highly-coloured statements which had come before our notice respecting the immense advantage of introducing a hydro-carbon vapour into the electric arc. We freely admitted that the light would be increased, but we doubted the practicability of the methods adopted to regulate the supply of hydro-carbon. Moreover, so far as the principle of the invention was concerned, we showed clearly enough that it was of many years standing. Our views were perfectly correct as the mechanism of the lamp then stood, but since that period Mr. Apps, the well-known scientific instrument maker, who has been indefatigably introducing improvements in rapid succession in the Saunderson arc lamp, appears to have overcome what then proved serious obstacles to its practical operation, in an entirely successful manner. The method of producing the extremely small supply of vapour necessary has now been reduced to a matter of the greatest simplicity, and credit is due to the inventor who gave Mr. Apps *carte blanche* to proceed as he pleased for the pertinacity with which he has stood to his guns in the face of innumerable difficulties. Accompanied by Mr. Apps a few nights since, we wended our way to a metropolitan railway station, where a Brockie-Pell lamp, fitted with Saunderson's carbons, had been for some weeks regularly working in series with a number of Brush arcs. Naturally, in the absence of proper apparatus, we were unable to compile any definite photometric data; but by roughly measured shadow tests and other simple means, we had little difficulty in perceiving that the light was much superior to that given by each of the others—at least half as much again. The cost of producing this extra luminosity, Mr. Apps informed us, does not exceed 6 per cent. on the price of ordinary carbons, and it is proposed to sup-

ply the hollow carbons with the hydro-carbon attachment, which are made to suit any lamp, to the trade generally, on the basis of a very small royalty on the market price. This is a wise course to pursue, and doubtless Mr. Saunderson will reap much more benefit from universally dealing with lamp makers than by the course of promoting a company to exploit and introduce his invention as an improved lamp, such as at one time seemed probable. His greatest sphere of operations, we imagine, will be found in America and in certain continental countries, for the development of arc lighting here is slow and tedious in the extreme.

State Control and Telephony.

OUR friend, the *Electrician*, is, to put it mildly, a trifle shaky in its political economy. Having advocated in the strongest terms the purchase of the telephones by the State, Mr. H. W. Fawcus has written, putting the truth before our contemporary in language pretty similar to what we used in our leading article a fortnight since. The *Electrician* now declares itself utterly opposed to Socialism, but qualifies the declaration with the remark that the position of the Post Office is no more one of State Socialism than is the War Office. Whether the monopoly of letter carrying and telegraphing by the State is justifiable need not be here considered, but there is no doubt that its existence illustrates a distinct phase of Socialism, while the position of the War Office is a very different matter. It is the function of the State to protect the citizens from foes abroad and friends at home if need be, to dispense justice and enforce rights between man and man, thus maintaining a condition of things under which individual enterprise may develop and secure its due reward. The War Office undertakes to deal with the foreign foe, but it is scarcely necessary that for the protection of individual interests at home the State should carry the citizens' letters, deliver their telegrams, or keep telephonic bureaux open. In fact, our contemporary fails like a good many others to distinguish between what the State ought to do and what it should let alone, between the duties for the performance of which it exists and the affairs with which it has no business. Though the *Electrician* declares loudly enough for "no Socialism," due to that extraordinary obliquity of vision which distorts political views generally, it sees nothing subversive of its principles in a letter-carrying monopoly, in State controlled telegraphy, in Government subsidies to newspapers, or in officially managed telephony. The principle of Individualism is approved, and as that of Socialism has been disavowed, it becomes convenient to call schemes essentially socialistic in their character and scope, by another name. So our contemporary regards the supply of electricity as a commercial undertaking, but the supply of telephonic facilities as a State affair. Given a political creed, it is always easy to find excuse for an infraction of its tenets should such infraction be thought for the time expedient.

License to the Mutual Telephone Company.

REFERRING to the projected telephonic competition at Manchester, our contemporary, in the same article to which we refer above, says:—"For our part we cannot help thinking that one of its first and chiefest difficulties will be to obtain the licence of the Postmaster-General." Would it surprise our contemporary to know that the license is already granted?

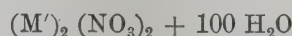
# EXPERIMENTAL PROOF OF HELMHOLTZ'S RELATION.

THE difference between the chemical and the electrical energy of a cell is equivalent to the product of the absolute temperature with the change in the difference of potential, with the change of temperature, or, in other words, with the temperature coefficient of the cell. This is the theory enunciated by Helmholtz some time ago. According to this hypothesis, if the chemical energy of any given cell is greater than its electrical energy, the temperature coefficient is negative; whilst, on the other hand, if the electrical energy of the cell is greater than its chemical energy, the temperature coefficient is positive.

It is evident, on considering this theory, that if the temperature coefficient can be ascertained, it may at once be determined whether the chemical energy of the cell is only partially converted into electrical energy or whether the electrical energy of the cell is in excess of its chemical energy.

Experiments to prove Helmholtz's relation between the secondary heat of a galvanic element and its temperature coefficient were undertaken a short time ago by H. Jahn, who afterwards published his results in a paper which may be read in Poggendorf's *Annalen der Physik und Chemie*, Series II, Vol. xxviii., page 491.

The cells examined by Jahn were silver and silver nitrate with lead and lead nitrate, and with copper and copper nitrate respectively. The solutions were made up to a strength represented by the following formula:—



when M' stands for the metal employed. NO<sub>3</sub> for the "nitrate" part of the salt, and H<sub>2</sub>O for water.

Jahn was successful in obtaining a number of exceedingly interesting results, of which we may briefly allude to certain that are typical.

The chemical heat of a galvanic element is obtained from the formula—

$$Q = W - a J (\Delta - J \sigma) t$$

in which the letters have the following significance.

W = The heat evolved in the cell.

a = The heat equivalent of unit of work.

J = The current intensity in amperes.

$\Delta - J \sigma$  = The difference of potential of the electrodes.

t = The duration of the experiment.

The value obtained from this formula for Q, the chemical heat of the galvanic element, agree closely with those obtained from thermo-chemical data.

If Q' stand for the current heat and S for the secondary heat, then the secondary heat is given by the equation—

$$S = Q - Q'$$

that is to say, the chemical heat, less the current heat, gives the secondary heat which is compared with that obtained by calculation from Helmholtz's relation.

Here are some specimens which illustrate this and at the same time show the accuracy of Jahn's experimental work:—

## ELEMENTS.

Results.	A		
	Ag <sub>2</sub>	Ag <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>	Pb (NO <sub>3</sub> ) <sub>2</sub> , Pb.
E.M.F. ... ..	...	...	= 0.932
Chemical heat ... ..	...	...	= 50.870
Current heat ... ..	...	...	= 42.980
Secondary { Found ... ..	...	...	= 7.950
Heat { Calculated ... ..	...	...	= 7.890

Results.	B		
	Ag <sub>2</sub>	Ag <sub>2</sub> (NO <sub>3</sub> ) <sub>2</sub>	Cu (NO <sub>3</sub> ) <sub>2</sub> , Cu.
E.M.F. ... ..	...	...	= 0.458
Chemical heat ... ..	...	...	= 30.040
Current heat ... ..	...	...	= 21.120
Secondary { Found ... ..	...	...	= 8.920
Heat { Calculated ... ..	...	...	= 8.920

These investigations into the equivalence of chemical energy and current energy have been supplemented quite recently by F. Streintz who has contributed an excellent paper to Poggendorf's *Annalen der Physik und Chemie*, Series II., Vol. xxxviii., p. 514.

In this paper he discusses Helmholtz's theory, and gives the results of an elaborate series of experiments undertaken by himself, and especially calls attention to his experiments with a silver-mercury cell and its relation to temperature.

Streintz observed some time ago that a cell composed of the following elements—



has an electromotive difference of potential of zero at the ordinary temperature. This was not explained at the time, but he now finds that the phenomenon is due to the fact that a change from positive to negative takes place here in the temperature coefficient, and that this change takes place at a certain temperature, T<sub>0</sub>, at which the difference of potential, p<sub>0</sub>, is equal to zero.

Hence it follows that if a silver mercury cell be plunged into ice-cold water, the silver forms the positive pole, whereas when the element is transferred to hot water, the mercury forms the positive pole, and the silver becomes negative.

Streintz has used this interesting cell in testing the theory of Helmholtz, which is briefly enunciated at the commencement of this paper, and he finds that there is a perfect agreement between the theoretical deductions of Helmholtz and his own experimental results. For the numerical data we must refer our readers to the original paper.

## THE ELECTRIC LIGHT AT BOMBAY.

[FROM A CORRESPONDENT.]

THE late Municipal Commissioner of Bombay last year advertised for tenders for the electric lighting of the city. These advertisements appeared in the two Bombay dailies, in some of the leading English papers, and in some American journals. Five tenders were sent in, particulars of which have been inserted in the Bombay papers.

The first of these was from Siemens Brothers, of Berlin. This company offered to erect and supply for £40,000 a complete generating plant and system of underground leads adapted for 5,000 glow lamps, 16 candle-power, but excluding cost of opening up streets, house, and street lamp connections.

Crompton & Co. proposed two alternative schemes for arc and glow lights respectively. The former plan would comprise 41 arc lamps of 2,000 candle-power, at 80 yards apart, the machinery in duplicate, but the site and machine house to be supplied by the municipality. Their prices are stated in such a manner as not to be easily comparable with the tender of Siemens Brothers and Co.

Laing, Wharton and Down propose an arc light system, including 33 lights for the road from the Apollo Bunder to the Crawford Markets and 20 in the markets. The lights are to be each of 2,000 candle-power, and to be charged for at the rate of £32 a lamp annually for two years, £30 if for three years, and £29 if for seven years.

Ganz & Co., of Buda-Pest, offer to light those parts of the Crawford Markets where gas is now used, with 14 arc lamps and 32 glow lamps of 25 candle-power each. They offer also to light the road from Crawford Market to the Apollo Bunder, Church Gate Street, and Elphinstone Circle, with 144 glow lamps of 25 candle-power placed 164 feet apart on opposite sides of the road. In addition they would supply 32 arc lights and illuminate the Clock Tower. The present amount of light now given in the streets is 2,800 candle-power; their glow lamps alone would give 3,600 candle-power, and the arc lamps 12,800. The annual charge would be 80,000 Rs.

Finally, the Orient Electric Light Company proposed to light the markets and the streets above-mentioned (except from St. John's Church to Colaba point), for two years with 650 lights of 16 candle-power. Their charge would be 5 pice per light hourly.

At a meeting of the Standing Committee of the Municipal Corporation, held June 25th, it was agreed that the commissioner be requested to prepare a special report on these schemes, and that he be authorised to apply to Government for the services of an electrical engineer, and also to expend any sum not exceeding 1,000 Rs. in making any needed scientific enquiries.

### AN EXPERIMENTAL PROOF OF OHM'S LAW, PRECEDED BY A SHORT ACCOUNT OF THE DISCOVERY AND SUBSEQUENT VERI- FICATION OF THE LAW.\*

By Prof. ALFRED M. MAYER.

I PURPOSE giving in this paper a simple and direct experimental proof of Ohm's law ( $C = \frac{E}{R}$ ). Generally

a mere formal statement of this law, with illustrations, are given in text books on physics, and the student is left to infer that its truth is shown by the cumulative evidence given by the immense number of quantitative relations in electrical actions which the law associates, and by the experience that deductions made on the basis of this law agree in measure with the results of experiments. The latter fact is certainly one of the best proofs of the truth of the law; but, nevertheless, the relations between  $C$ ,  $E$  and  $R$  are not directly and simultaneously shown to be exactly expressed by

$C = \frac{E}{R}$ . It is true that some works give experiments to show this relation, but they are so difficult to perform by reason of the difficulty of maintaining constant  $C$ ,  $E$  and  $R$ , that the results of the experiments only approximate to those required by the law.

Ohm was led to the conception of this law by *assuming* that the flow of electricity in a voltaic circuit is similar to the flow of heat by conduction in a rod of indefinite extent. Also, his assumptions that the actions of two electrified particles are directly as their distance, and that the electricity is uniformly dense over each cross section of a conducting wire, were directly opposed to the laws and facts well established by Coulomb for statical electricity. It is not surprising that scientific men were slow in adopting the views and theory of Ohm. In his memoir (*Die galvanische Kette mathematisch bearbeitet* von Dr. G. S. Ohm: Berlin, 1827) he states:† "Three laws, of which the first expresses the mode of distribution of the electricity within one and the same body, the second the mode of dispersion of the electricity in the surrounding atmosphere, and the third the mode of appearance of the electricity at the place of contact of two heterogeneous bodies, form the basis of the entire memoir, and at the same time contain everything that does not lay claim to being completely established. The two latter are purely experimental laws; but the first, from its nature, is, at least, partly, theoretical.

"With regard to this first law, I have started from the supposition that the communication of the electricity from one particle takes place directly only to the one next to it, so that no immediate transition from that particle to any other situate at a greater distance occurs. The magnitude of the transition between two adjacent particles, under otherwise exactly similar circumstances, I have assumed as being proportional to the difference of the electric forces existing in the two particles; just as in the theory of heat, the transition

of caloric between two particles is regarded as proportional to the difference of their temperatures. It will thus be seen that I have deviated from the hitherto usual mode of considering molecular actions introduced by Laplace, and I trust the path I have struck into will recommend itself by its generality, simplicity, and clearness, as well as by the light it throws upon the character of former methods.

"With respect to the dispersion of electricity in the atmosphere, I have retained the law deduced from experiments by Coulomb, according to which, the loss of electricity in a body surrounded by air, in a given time, is in proportion to the force of the electricity, and to a coefficient dependent on the nature of the atmosphere. A simple comparison of the circumstances under which Coulomb performed his experiments, with those at present known respecting the propagation of electricity, showed, however, that in galvanic phenomena the influence of the atmosphere may almost always be disregarded. In Coulomb's experiments, for instance, the electricity driven to the surface of the body was engaged in its entire expanse in the process of dispersion in the atmosphere; while in the galvanic circuit the electricity almost constantly passes through the interior of the bodies, and consequently only the smallest portion can enter into mutual action with the air; so that in this case the dispersion can comparatively be but very inconsiderable. This consequence, deduced from the nature of the circumstances, is confirmed by experiment; in it lies the reason why the second law seldom comes into consideration.

"The mode in which electricity makes its appearance at the place of contact of two different bodies, or the electrical tension of these bodies, I have thus expressed:—When dissimilar bodies touch one another, they constantly maintain at the point of contact the same difference between their electroscopic forces (potentials).

"With the help of these three fundamental positions, the conditions to which the propagation of electricity in bodies of any kind and form is subjected may be stated. The form and treatment of the differential equations thus obtained are so similar to those given for the propagation of heat by Fourier and Poisson, that even if there existed no other reasons, we might with perfect justice draw the conclusion that there exists an intimate connection between both natural phenomena; and this relation of identity increases the further we pursue it. These researches belong to the most difficult in mathematics, and on that account can only gradually obtain general admission; it is therefore a fortunate chance that in a not unimportant part of the propagation of electricity, in consequence of its peculiar nature, those difficulties almost entirely disappear."

From these premises, and guided by results of experiments made by him and by Ritter, Erman, Jäger, Davy and Becquerel, he arrived at the following conditions as existing in a voltaic circuit.

1. In a homogeneous conductor, forming part of a voltaic circuit, the difference of the electric tensions at any two points of the conductor is proportional to their distance.

2. In different conductors forming part of a circuit, the difference of tensions at two points separated by an interval equal to the unit of length is in the inverse ratio of the section of the conductor and of its coefficient of conductivity. Hence, in different conductors, equal differences of tension correspond to lengths whose electric resistance is the same.

3. At the point of contact of two different conductors, there is a sudden variation of electric tension.

4. If  $A$  equals the sum of the electromotive forces,  $L$  the resistances,  $\lambda$  the resistance reckoned from a point,  $m$ , of the circuit to a point,  $p$ , when the tension is zero, the tension at the point,  $m$ , is given by the formula,

$$u = A \frac{\lambda}{L}.$$

Ohm eventually arrives at the formula  $S = \frac{A}{L}$ , which

\* American Journal of Science.

† See translation, published in Vol. II. of Taylor's Scientific Memoirs, p. 402. London, 1841.

expresses what is generally known as his law. Which formula, he says, "is generally true, and already reveals the equality of the force of the current at all points of the circuit; in other words, it may be thus expressed: The force of the current in a galvanic circuit is directly as the sum of all the tensions, and inversely as the entire reduced length of the circuit, bearing in mind that at present by reduced length is understood the sum of all the quotients obtained by dividing the actual lengths corresponding to the homogeneous parts by the product of the corresponding conductivities and sections."

The words "tension" (*Spannung*) and "electromotive force" used by Ohm are the equivalent of the word *potential*. He was the first to introduce this conception into the theory of the voltaic circuit and to the above words and to *current* and *resistance* he attached precise meanings and showed the relations existing between those quantities. The clear definitions Ohm gave of these terms marked a transition from vague ideas of "quantity" and "intensity" to the clear conceptions of potential, electromotive force, current and resistance. The word *energy* he also used with clear and accurate meaning, as is shown in the following statement: "That the decomposing force of the circuit is in direct proportion to the energy of the current, and, moreover, that it depends on a coefficient, to be derived from the nature of the constituent parts and their chemical equivalents." This was published in 1827, six years before Faraday's researches on electrolysis.

energy of a given current would be spent in this way, would require a far more perfect knowledge of the dynamical theory of bodies than we at present possess. It is only by experiments that we can determine the laws of processes of which we do not understand the dynamical theory."

Surely, if an experiment, that is easily made, shows the truth of a law of such theoretical and practical importance as that of Ohm, even if it is one restricted in its range of C, E, and R, but shows within its limita-

tions the relations  $C = \frac{E}{R}$  then it should be made by

all teachers of physics so that clear physical conceptions of those relations may be given to students. As those who have seen these experiments have deemed them worthy of being more generally known, I now publish an account of them.

In the diagram, fig. 1, the parts of the apparatus are shown, but not at their relative distances apart or in the proper proportions as to size. G is a low resistance Thomson galvanometer. At L is the condensing lens of a lime-light lantern, which is covered with a cap having a rectangular opening in it. Across the middle of this slit is a vertical wire. The scale of the galvanometer is at C, distant 165 cms. from the mirror of the galvanometer. The width of the divisions on this scale are 2.5 cms., and the lines are drawn 2.5 mms. in breadth, or  $\frac{1}{10}$ th the distance apart of the centres of the lines forming a unit of the scale. The scale is at such

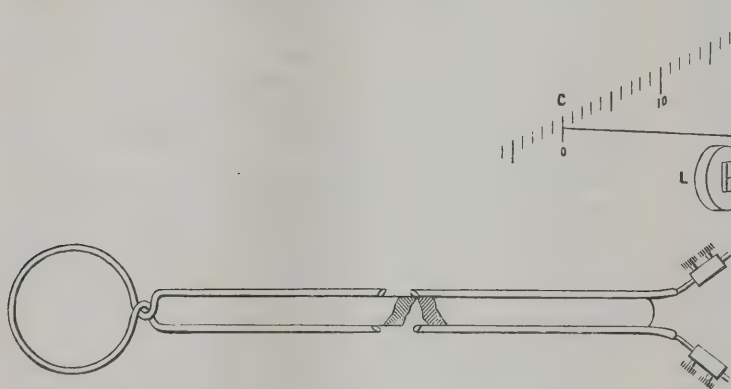


FIG. 1.

Neither Ohm nor his contemporaries were able to test the truth of the four statements given above as embodying Ohm's theory. It was reserved for Kohlrausch in 1849 to show by very ingenious and accurate experiments that Ohm's statements were true in mode and in measure. Kirchhoff\* and Quincke† applied with success Ohm's theory to the flow of electricity in thin conducting plates, or bodies of two dimensions, and the same was done by Smaassen,‡ not only in a plane but in bodies of three dimensions. The most remarkable confirmation of Ohm's law was made in 1876§ by experiments suggested by Maxwell and performed by Chrystal in the Cavendish Laboratory, Cambridge, "in which the testing of this law seems to have been carried to the limit of experimental resources."

Though Ohm's law has thus received such ample verification that it ranks with the best-established laws of nature, yet, as Maxwell says: "Ohm's law must, at least at present, be considered a purely empirical one. No attempt to deduce it from pure dynamical principles has as yet been successful. . . . The conduction of electricity through a resisting medium is a process in which part of the energy of an electric current, flowing in a definite direction, is spent in imparting to the molecules of the medium that irregular agitation which we call heat. To calculate from any hypothesis as to the molecular constitution of the medium at what rate the

distance from the galvanometer mirror that the image of the vertical slit just fits in the space of a scale unit, while the breadth of the image of the vertical wire is exactly equal to the breadth of a scale line. This arrangement gives the means of observing a deflection of the beam of light to  $\frac{1}{10}$ th and  $\frac{1}{20}$ th of a unit with quickness and accuracy.

The image of the slit is so bright and that of the wire so distinct that this method of observing deflections of the galvanometer may be used in broad daylight and the deflections may be read throughout the room.

An incandescent electric lamp with a part of its surface (behind the plane of its filament) silvered may replace the lime light. Thanks to this arrangement, I have been able during many years to make before my class electrical measurements, and to measure the radiation, reflection, refraction, diathermancy, and polarization of radiant heat.

At M is a magnet 25 cms. long and  $1\frac{1}{2}$  cms. in diameter. On this magnet slides a wooden disc. At R is a box containing 1, 2, and 3 ohms of resistance, made of coils of copper wire.

An insulated copper wire wound at its middle in a circle of one coil, or in a spiral of any number of coils is placed over the magnet and rests on the top of the wooden disc. Fig. 2 shows (one-half size) how this circle of one coil is made. It is bent around a wooden cylinder  $3\frac{1}{2}$  cms. in diameter, and then the free ends of wire are bent one-half turn on each other. The free lengths of the wire are then lashed to a light square rod of wood, as shown in figure. The wire and rod are then coated with shellac to cement them firmly to-

\* Pogg. Ann., t. lxiv., 1845, and t. lxvii., 1846.

† Pogg. Ann., t. xcvi., 1856.

‡ Pogg. Ann., t. lxiv., and t. lxxii.

§ Brit. Assoc. Rept., 1876, p. 36.

gether. Rings of spirals of 2, 3, 4, 5 and 6 coils are also made in the same manner, but the coils are in spiral, *i.e.*, in one plane, and are then cemented together with shellac between rings of thin card-board.

The length of wire forming each of these rings of spiral coils with the portion on its handle is one meter long.

The resistance of this length of wire, added to the resistance of the lengths between it and G and R, together with the resistance of the galvanometer is (for convenience) made one ohm.

It may be well here to speak of the adjustment of the galvanometer before describing the experiments, for I have noticed in some laboratories and lecture rooms galvanometers which are used not as they should be. I have noticed that the damping magnet formed a considerable angle with the plane of the coil. This was either because the medium plane of the coil was not in the magnetic meridian or because there was considerable torsion in the suspending thread.

In these galvanometers, or, at least, in mine, the median plane of the coil is placed parallel to the faces of the drum of the instrument. The plane of one of these faces is brought in the magnetic meridian of the room, which has been carefully drawn on the table under the vertical centre line of the galvanometer coil, by means of a long magnetic needle mounted like those used on plane tables. A line at right angles to this meridian is now drawn so that its point of intersection with the meridian line shall be exactly under the suspending thread of the mirror. In the vertical plane of the line, drawn at right angles to the meridian, is placed the vertical wire in the slit of the lantern, L, and also the zero line of the scale, C. The scale is parallel to the magnetic meridian. The galvanometer is now placed in the position given above, and the "directing magnet" removed to a distance. The image of the vertical wire at L will now be found on the zero of the scale if there is no torsion in the suspending thread. If it does not come to zero then the head of the rod to which the thread is attached is turned till image of wire coincides with zero of scale, and then the instrument is in adjustment, and it will give deflections as the tangents of the strength of current, or, in other words, the current strength will be directly as the readings on the scale. The magnet, M, is now placed so that it causes no movement of beam from the zero of the scale. The directing magnet, above the coil, is now so adjusted that the time of an oscillation of the magnet of the galvanometer is above five seconds.

The coil, E, over the magnet is put in the circuit of G and R. The wires between E and G and R are twisted and tied together, so that no induced current from the earth's magnetism may be caused by the motions of this part of the circuit. The image of wire is on zero of scale. Now on rapidly lifting the coil from around the magnet, a deflection is produced by the magneto-electric current thus generated. It is sufficient to know that the cause of this current is the quick lifting of the ring with one coil. If we replace this by a ring of two coils, we get twice the deflection, and rings of 3, 4, 5 and 6 coils give 3, 4, 5 and 6 times the deflection given by the ring with one coil. Adopting the conception of the lines of magnetic force, we say that the ring with one coil cuts a certain number of these lines, this cutting of the lines causes the current, and is the *electromotive force*. The ring with two coils makes two cuts of these same lines, or, cuts double the number of lines, the rings of 3, 4, 5 and 6 coils cut 3, 4, 5 and 6 times the number of lines, and hence give 3, 4, 5 and 6 times the electromotive force.

In these experiments the resistance of the circuit has remained constant. Now take the ring with 5 or 6 coils, and let us have one ohm as resistance of circuit. On lifting ring from magnet we get a certain deflection, which we may make exactly equal to a whole number of the units of the scale by sliding up or down the disc on the magnet. We now take out plug of resistance box, and make the resistance of the circuit two ohms. The deflection of the galvanometer magnet now becomes one-half of that of previous experiment, and

successively making the circuit with resistances of 3, 4, 5, 6 and 7 ohms, we get  $\frac{1}{3}$ rd,  $\frac{1}{4}$ th,  $\frac{1}{5}$ th,  $\frac{1}{6}$ th and  $\frac{1}{7}$ th of the deflection we got with one ohm in circuit.

When these experiments are made with the galvanometer in perfect adjustment, and with the precautions indicated below, the deflections arrive one after the other exactly as the law requires, thus showing, with sufficient precision for a lecture experiment, that the current is directly as the electromotive force, and inversely as the resistance. Indeed, generally, the closest scrutiny does not detect in the scale reading any departure from the law.

Certain precautions are, however, necessary in these experiments. The resistance outside the galvanometer must be of copper wire, for such is the wire of the galvanometer. Also, the whole of the apparatus must be put together the day before we make the experiments, and the room maintained at as constant a temperature as possible, so that the temperature of all parts of the apparatus is the same. The deflections should not exceed 15 divisions of the scale. Thus, if we start with 15 divisions of deflection for a resistance of one ohm we will get 7.5, 5, 3.75, 3, 2.5, and 2.143 deflections for resistances of circuit of 2, 3, 4, 5, 6 and 7 ohms; and if with a constant resistance we obtain a deflection of two divisions of scale with a ring of one coil, we will get deflections of 4, 6, 8, 10 and 12, with rings having 2, 3, 4, 5 and 6 coils.

It is necessary that the coils should be removed from the magnet *very quickly*, otherwise the deflections will not be as the law requires. In other words, the currents produced should be as instantaneous as can be obtained. Instead of rapidly removing the coils by the hand, I have sometimes lashed the coil and their handles to a spring-board with a hole in it, which went over the magnet. By a trigger this spring-board is released. We thus get the same velocity in lifting the coil in each experiment. We have found, however, that the hand of a good experimenter gives precise results. Sometimes I have sent the coil from the magnet by the blow of a stick delivered on the under side of the handle of the coil at its centre of percussion. There is no doubt some departure from the law in these experiments, for it is not possible in such experiments to obtain what is understood by instantaneous currents; and the damping of the magnet by the mirror acting on the air must come into play. Yet I have never seen any but insignificant and barely discernible departures from deflections required by the law. This follows from the small angles of deflections and low velocity of the motion of the galvanometer magnet in the experiments. It is also to be noticed that with a good magnet of the size stated, and with the galvanometer making one vibration in about five seconds, the coil with five turns passes over only 2 cms., or less, of end of magnet, in order that it shall give a deflection of 15 divisions of scale. It is evident that in these conditions a very short time is occupied in cutting the lines of force. If the maximum deflection used is 15 divisions of the scale, the actual angular deflection of the magnets and mirror amounts to only  $6^{\circ} 29'$ . Yet 15 divisions is quite a length on the scale, being equal to 37.5 cms. But these experiments may be as readily made with a ballistic galvanometer. Then the magnets and coils have to be of larger dimensions.

Experiments similar to those given have served to graduate galvanometers. We have here the means of sending definite amounts of currents through an ordinary galvanometer, and we may thus graduate its angular reading into their relative values in current. The damping of the galvanometer has, however, to be applied to the readings, and then the results may best be put in the form of a curve.

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**Ozone.**—Mr. Ernst Fahrigh is the author of a paper in the *Chemical Trade Journal* for the 19th ult., entitled:—"The phosphorescence produced upon the first contact of ozone with certain fluids."

SOME POINTS ABOUT ALTERNATING  
CURRENTS.\*

By Prof. H. S. CARHART.

THE extensive use of alternating electric currents in the transmission of energy for the purpose of lighting and, to a limited extent, for power, necessitates a more general and exhaustive study of their action than formerly. Alternating current dynamos were early in the field, but their importance was not fully apprehended till after direct current apparatus had come into extensive use, not in fact till transmission at high voltages for incandescent lighting was made possible by the application to alternate current circuits of the inverted induction coil, called a transformer or converter. Since then alternating current apparatus has come rapidly to the front, and many eager investigators have made brilliant applications of it to practical purposes.

The phenomena of alternating currents are so totally different from those of direct currents that the electrician, whose conceptions touching electrical action have been largely derived from the application of Ohm's law, finds himself entirely unable to comprehend alternate working till his views have been modified by an attentive consideration of many new and perplexing facts.

The first of these facts is self-induction, which plays no part in direct current working except on opening or closing the circuit, but which is exalted to a plane of prime importance with alternate currents. It is to Prof. Joseph Henry that we owe the first clear apprehension and lucid explanation of this interesting phenomenon.

When a simple periodic E.M.F. is applied to a circuit so disposed that its different parts act inductively upon one another, then this E.M.F. does work, not simply against the ohmic or ordinary resistance of the conductor, by reason of which heat is generated, but also against a counter E.M.F. of its own creating. We are familiar with this division of work when power is transmitted to an electric motor. The impressed E.M.F. then meets with ohmic resistance generating heat, and with a counter E.M.F. in the motor, the armature of which revolves in a magnetic field, and, in virtue of this counter E.M.F., a part of the energy applied to the circuit is converted into mechanical work at the motor. Energy may thus be stored up by means of the counter E.M.F. arising in the motor.

In an analogous way when energy is applied to an alternating current circuit a part of it is lost in heat, and a part is alternately stored up in the magnetic field and again restored to the circuit. A small portion in practical working, probably a very small portion of the energy, is transmitted outward into space as electrodynamic waves with the velocity of light.

Such a circuit possesses two qualities, resistance and inductance. The former is a property by virtue of which the passage of a current is accompanied by the irreversible transformation of electric energy into heat; the latter is a property by virtue of which the passage of a current is accompanied by the absorption of energy in the form of a magnetic field. A part of the energy spent on the conductor is frittered away in irrecoverable heat, while the other part is associated with the circuit in a recoverable form. When the applied electromotive force diminishes or ceases altogether, this stored-up energy operates to carry the current forward. On account of self-induction a current appears to possess inertia, and so resists any change tending in either the direction of increase or of decrease. A flywheel, to which the turning force is applied to increase the angular velocity, is the mechanical analogue. Suppose no resistance except friction opposes the motion of the wheel. Then a part of the energy applied is converted into heat by friction, and a part is stored up in the motion of the wheel in a recoverable form, to be given out or restored when the turning force is withdrawn.

The effect of the inertia of the wheel is to resist the force tending to increase angular acceleration, and to keep up the motion of the wheel in the positive direction when the twisting force is withdrawn. So the inertia or self-induction of a current opposes any change either of increase or decrease in the current. It does more; it continues the current in the positive direction even after the impressed E.M.F. is withdrawn. If the force applied to the flywheel is gradually brought to a zero value, and is then gradually applied with increasing intensity in an opposite direction, the wheel will continue to turn in the positive sense after the force is applied in the negative sense. In other words, the phase of the wheel's motion lags behind that of the applied force, its zero occurring later than the zero of the force. During this period of motion in one direction and force applied in the other, the wheel is doing work on the agent applied to it. While the angular velocity of the wheel is increasing, the agent is doing work on the wheel, and the wheel is storing up energy.

In quite the same way when a simple periodic E.M.F. acts on an inductive circuit, the current lags behind the E.M.F. in phase. It reaches its maximum value after that of the impressed E.M.F. by an interval equal to the angle of lag expressed in time, and passes through its zero value at an equal interval of time later than the zero of E.M.F.

Hence there arises a second fact worthy of particular attention. The maximum current never reaches a value equal to the maximum E.M.F. divided by the resistance of the circuit, but falls short of this by a quantity depending upon the coefficient of self-induction and the rapidity of alternation. By the coefficient of self-induction is generally meant a constant,  $L$ , such that the product of this constant and the rate of increase or decrease of the current is the E.M.F. of self-induction. By Ohm's law the current equals the E.M.F. divided by the resistance; with alternating currents in an inductive circuit the maximum current equals the maximum E.M.F. divided by a quantity  $R^2 + L^2 p^2$ , in which  $R$  is ordinary resistance,  $L$  is the coefficient of self-induction or the inductance, and  $p$  equals  $\frac{2\pi}{T}$ ;  $T$  being the

period of alternation. The above expression is now often called impedance, or sometimes "apparent resistance."

Another noticeable difference between direct and alternating currents is that while with the former the rate of doing work is the product of the current and the E.M.F., or C.E., in the latter the mean activity is half the product of the maximum E.M.F., the maximum current and the cosine of the angle of lag, or  $\frac{1}{2} E C \cos \phi$ . When the angle of lag is zero the

activity is a maximum, or  $\frac{1}{2} E C$ . When the lag is  $90^\circ$ ,

or a quarter of a period, the activity is zero. Thus we have the remarkable combination of a periodic E.M.F. applied to a circuit, a periodic current flowing through it, and still no work done upon the circuit. "In this case there is no frictional dissipation of energy, but simply a give and take of energy between the magnetic field and the source of energy supplying the E.M.F." Thus the mains of an alternating circuit may be joined by a conductor of such high inductance, that approximately no energy will be transmitted across from main to main. Such is the case with a so-called "choking coil," or with a transformer when the secondary circuit is open.

Another point to which the electrician may profitably devote extended contemplation is the measurement of electrical quantities on alternating circuits. Several devices have been invented to serve as current integrators, notably those of Mr. Shallenberger and Elihu Thomson; but these are instruments serving rather for the commercial purposes of central station work than for scientific measurements of precision. The Siemens electro-dynamometer, when properly made of approximately non-inductive resistance, serves for the measure-

\* *Western Electrician*.

ment of the mean square of the current. It can be shown that the square root of this mean square is equal to the maximum value of a current, following the simple periodic law, divided by the square root of two.

To measure voltages the ordinary high resistance instruments will not answer at all, because they have high inductance. The Cardew voltmeter, which acts by the heat expansion of a straight wire, and some form of electrostatic instrument are the only device serving for the measurement of a simple periodic E.M.F. These again measure the mean square or the E.M.F., and this bears the same relation to the maximum E.M.F. as the mean square of the current bears to the maximum current. Hence the product of these two quantities equals  $\frac{E \cdot C}{2}$ . Neither of these instruments, however, gives

any indication touching the important angle of lag, and therefore they give no information respecting the electrical energy in the circuit, nor of the alternate storing and restoration of energy by means of the magnetic field. Dr. Louis Duncan has measured the efficiency of a transformer by means of a huge calorimeter. This method is undoubtedly accurate if carefully applied, but it is scarcely simple enough for general laboratory use. Much remains to be done in this direction.

Very much might be said in favour of electric lighting by alternating currents. Scientific tests have shown that the efficiency of such a system is not so high as its promoters would have us believe. Its great and undoubted advantage lies in its ability to transmit energy to a distance at high voltage, transforming to low voltage at the points where the energy is to be utilised in lighting. For high voltage means small conductors and economy in transmission, and low voltage at the glow lamp is a necessity.

#### FURTHER NOTES ON THE CAUSES OF DEATH BY ELECTRICITY.\*

By DR. EDWARD TATUM.

I NOTICE with pleasure that my results with dogs fully bear out the inference drawn by MM. Brouardel and Bourot† from their human autopsies, namely, that death from electricity is really initiated by cardiac arrest. I must say, however, in regard to autopsies in general, made after accidental electric shocks, that I do not think any (reasonable) number could be convincing as to the fundamental mode of death; for while their number might be large enough to include every lesion that electrical discharges could cause, yet, when several serious lesions appear in one autopsy, there is no way of knowing either the order in which they have been produced or, in fact, that any one of them has really been necessary to the fatal effect. I have, therefore, always thought that the only satisfactory mode of approaching the question would be one in which the action on different organs and functions could be discriminated in order of time.

It now seems certain that (with the animals and conditions that I have employed) cardiac arrest is invariably the real initiation of somatic death—no matter how strong the current may have been, nor what lesions of fatal dimensions may have been caused during the same application.

Permit me to review, very briefly, how I have reached this point, and how I have made an important further advance.

I started out with the object of finding the seat, and if possible the character, of the lesions by which electric currents might kill dogs.

I first eliminated the factor of general injury to muscles and nerves by showing that they could retain their physiological functions not only after the application of a current sufficient to produce somatic death,

but even after the direct passage through their substance of currents of more than tenfold the density that the fatal current had averaged in the neck. Neither was the blood discoverably changed by the direct application to isolated portions of it of equally dense currents.

I next eliminated the agency of the respiratory mechanism as a necessary factor by showing, on the one hand, that its functions might be retained and exercised even for several minutes after the heart had executed its last beat; while, on the other hand, I never succeeded in definitely arresting respiratory movements before the heart also had stopped. This I considered a most positive and important advance, for it eliminated from the inquiry everything except the central nervous system and the heart.

*Lesions* of the central nervous system were dropped from the account on the following grounds:—1. There is no cardiac centre in the central nervous system in the sense that there is a respiratory centre, such, namely, that the continuance of the heart's activity depends on the integrity of the centre, and ceases upon the destruction of the centre. 2. I have apparently passed, without fatal result, through the *euephalon* alone, considerably stronger currents than have traversed it when the chest has been included in a fatal circuit. 3. No increase in dose seems to be required, either with continuous or alternating currents, to arrest the heart after it has been separated from the central nervous system by the section of both pneumo-gastric nerves.

The only remaining modes that suggest themselves in which electric currents can arrest the action of the heart are three:—

1. By some action on the muscular substance of the heart, by which this muscle is directly deprived of the peculiar physiological property of originating its automatic beats.
2. By a stimulation to physiological activity of the nervous inhibitory mechanism of the heart, which has normally a restraining power over the heart.
3. A joint action, in which the two foregoing share the responsibility.

The part played by physiological inhibition is very clearly shown in the experimental results that I gave in the paper above-mentioned. I there contrasted the effects of battery currents (which deliver their electric energy with the least possible amount of nervous excitation) with rapidly alternating currents, which are far more efficient nerve excitants. The result was, as there stated, that the later currents proved also far more effective in arresting the heart.

That the *whole* of this difference in killing power is accounted for by the difference in nerve-exciting power is shown by the fact that, when the nervous mechanism was paralyzed in ether narcosis, the *difference* in efficiency between the two sorts of currents vanished, while the efficiency of the battery current was not reduced.

While with alternating currents the nerve-exciting property is responsible for at least more than half the result (since that is the lowest possible estimate of the fatal superiority of these currents), still this property is very probably not responsible for the whole of the mischief, since even in this case the currents must reach a certain very respectable density in order to kill.

With battery currents, however, it seems clear that at least nearly all the mischief is done directly to the heart muscle, since the different conditions under which they have been used have failed to show distinctly any factor that could be set down to nerve stimulation. A more direct and striking evidence, however, may perhaps be found in two experiments where I used dogs profoundly poisoned by *curare*.

This drug has the remarkable power of entirely emancipating from nervous influence (at least as far as experiment and inference can determine) all the *red* or *striated* muscular fibres in the body. When a dog is under its influence natural respiration is abolished together with all possibility of voluntary movement. This is not from any paralysis of the muscles, since they respond actively enough to direct electrical stimulation of their substance, but from the fact that they

\* *Electrical World*.

† "Annales d'hygiène publique et de médecine légale," April, 1885.

are cut off from the nervous direction, which they need in order to perform any natural action.

The heart muscle differs from all other red muscles in being what is called automatic; that is, it originates its own activity, and its contractions are not started by any nervous influence (though they are in the normal state unquestionably greatly modified by the nervous mechanism pertaining to the heart). The heart is, therefore, not directly stopped by curare; but, if artificial respiration is practised, it will go on beating regularly and vigorously until the poison is eliminated and the animal recovers.

Yet under this poison the animals succumbed to just about the same current density as when ether alone was used.

These, then, are the conclusions that I think I have legitimately established, for the animals and under the conditions mentioned:—

1. That, in death which follows an electric shock so quickly as to be called sudden, the heart is arrested as soon as, or sooner, than any other serious lesion of tissue or function is produced.

2. That, when a battery current is used, this cardiac arrest is brought about almost exclusively by some direct action upon the muscular substance of the heart, whereby its power of automatic contraction is lost.

3. That, when a rapidly alternating current is used, this cardiac arrest is brought about certainly very largely through the physiological cardio-inhibitory mechanism, although even here the direct action on the muscular substance is probably not without importance.

It is not yet known whether electrical currents, applied as I have described, produce a discoverable histological change in the heart. I have therefore not ventured to formulate the physical process by which the heart muscle is caused to lose its distinctive physiological functions. Perhaps that will have to be left to electricians. Probably the complete explanation—since it involves the as yet undefined relation which subsists between the physical and physiological properties of living matter—is yet a great way off. I am not without hopes, however, of being able to throw additional interesting physiological light upon the matter.

### PROF. LODGE'S COMMUNICATION ON "ALTERNATIVE PATH" EXPERIMENTS.

By S. ALFRED VARLEY.

THOSE who regard language as an instrument for word fencing will possibly find much to admire in the communication of Prof. Lodge that appeared in the last issue of the ELECTRICAL REVIEW.

Prof. Lodge does not condescend to reason; he speaks from an elevated pulpit, and seems to expect *our* ignorance to accept unquestioned the utterances of *superior* wisdom. At the same time, with the true instinct of an able artist, he delicately veils and tones down, with learned phrases, what, if only analysed, will be found to be little more than *ipse dixit*. I fear that I myself too often run into an opposite extreme, and tear to tatters what I am discussing by an over-anxiety to give a reason for everything; but I do my best to express myself in common-sense, understandable language; and those who read to learn will give me the credit, I think, of having seriously thought out what I venture to write about.

Now, in the journalistic correspondence which has occasionally occurred between Prof. Lodge and myself, he has never condescended to reason, and he seldom speaks from a level platform; the consequence is I cannot get into touch with him, and, from no fault of my own, I become forced into a more or less antagonistic attitude. Circumstances, combined with traditions, have tended to make me unconventional; I do not, therefore, fit properly into either the square holes or the

round holes society delights in, and every-day experience teaches me that not to be of a shape recognised by orthodox Cults is the unpardonable sin which can never be forgiven.

Prof. Lodge has, however, in his last communication shifted his ground a little, and I am thankful for small mercies. He *now* tells us that the spark observed at B is a derived spark. I agree with him that it is a derived spark, and I venture to say it is derived from the demagnetisation of the metallic path, and that it represents the percentage of energy transformed into magnetism in overcoming inertia, and which becomes temporarily occluded in the path, at the time the Leyden jar discharge is occurring.\* Now, having reached this stage, I find myself in a position to connect in an intelligible manner the spark at B with the inertia phenomena of *all* closed electric circuits, and what I observe both in galvanic as well as in dynamo circuits helps me to understand what happens when a Leyden jar discharge takes place through a metal path; and, further, as all knowledge reacts I have been able to clear up in my own mind certain difficulties in connection with the transmission of rapid alternations through conductors by studying what is observed when Leyden jars are discharged through metal paths.

Now, I dare venture to assert that neither Sir William Thomson nor Prof. Lodge will take upon themselves to say, in clear unambiguous language, that I am wrong in attributing the spark seen at B to current developed in the conductor during the act of demagnetisation, and in saying, as I do, that this spark arises simply from the completion of the circuit through the short air space that separates the metallically disconnected ends of the wire loop; but at the same time, if the truth be told, these two distinguished physicists would, I believe, do almost anything rather than admit the soundness of my conclusions, for to do so would be tantamount to admitting that I have successfully stormed an important stronghold of the newer theory.

Prof. Lodge says in his communication that the current of a Leyden jar is very strong whilst it lasts, but he gives no reasons why it is so, and in such matters as these the writings of Prof. Lodge and those of mine contrast very strongly; what he has put forward simply as a statement I have demonstrated, and I believe I am the only physicist who has ever undertaken the task of doing so. I have shown the connection that exists between ordinary Leyden jars, decomposition cells, plating baths, storage batteries, and voltaic cells, and I have pointed out that a charged Leyden jar is fairly comparable to a voltaic couple whose internal resistance approaches the infinitely great, and yet, for reasons developed in my articles, a Leyden jar discharge comports itself during an infinitely short interval of time as a voltaic cell whose internal resistance approaches the infinitely small. Men such as Faraday considered themselves to be simply students somewhat older in experience than their pupils, and their efforts were directed to setting their pupils thinking; but all this has been changed since certain mathematical physicists have claimed to be the authorities in electrical science. In place of reasoning, we have authoritative statements from scientific gods, and it is considered the rankest of heresy to question in any way the sensational utterances they from time to time thunder forth.

Now, my contention is that I have fairly analysed Prof. Lodge's so-called alternative path experiments; and I say that these experiments performed by himself demonstrate, as clearly as experiment can demonstrate, a scientific fact that Leyden jar discharges pass through the mass of a conductor. I further say, as I have already stated in my criticism of Sir William Thomson's paper, that what was observed when a cold cylindric iron frame, forming two paths for the alternations to pass through, was placed in the electric welder, did not suggest in *any way* a crowding of currents in the outer skins.

\* Reasons have been given at length in the course of the articles, and I have connected, by *consecutive* reasoning, all that I have published.

The communication of Prof. Lodge, published in *Industry*, has reference to my criticism of Sir W. Thomson's paper, but he passes wholly unnoticed the experiment I laid the most stress upon, as bearing more directly on the matter at issue, viz., the crowding of transient currents in the outer skins of conductors; and now Prof. Lodge expresses surprise at my taking exception to his having done so. In my articles I have analysed self-induction, and I have pointed out that on the assumption that my explanation is the true one, the inertia resistance of iron should become reduced after a red-hot temperature has been reached. I believe I am right in saying that no one but myself has hitherto given thought to this matter, and I have not yet had an opportunity of verifying it. Prof. Lodge *now* says *it is so*, no reasons are given, and I am not credited with the suggestion, but the giving me any scientific credit is what he and those brother professors of his, who not so very long ago opposed me in the law courts, are evidently very unwilling to do. Sir William Thomson, in the Court of Sessions, Edinburgh, took credit to himself for having become possessed of a shunt machine in 1880. He said that next to nothing was known of such machines at that period, and the burden of the song sung by the three professors was that as *they themselves* knew very little indeed about shunt machines even in 1880, *how was it possible* for Mr. Varley to design an advance on such machines in 1876.

It is no good pummelling straw, as Prof. Lodge remarks, and the leading horses to a stream if they do not desire to drink is about as useless. The fact that the ELECTRICAL REVIEW, in which the communication of Prof. Lodge appears, also contains the judgment lately given at the Court of Appeal at Edinburgh in the compound winding case, I hail none the less that it is purely accidental. My claims as a discoverer, which certain of our mathematical physicists have been doing their very best to ignore and to spirit away, have now been triumphantly sustained in two law courts. The judgment given in the Court of Sessions declared the evidence of certain highly-distinguished professors to be *neither* reasonable *nor* fair. The Court of Appeal has confirmed this judgment and expressed its surprise that a number of able and distinguished men "*should have been persuaded*" to give the evidence they did.

I have no desire to prolong this discussion. I shall repeat, as soon as I am able, the accidental experiment of Lord Armstrong, to which Sir William Thomson has imparted so much importance; but I think it quite possible that in the mean time we may have promulgated some more of what Prof. Lodge has so happily termed "unique corrections of formulæ."

## GAS WORKS AND ELECTRIC LIGHTING.

AT the annual meeting of the North British Association of Gas Managers, held at Perth last week, Mr. S. Stewart, in the course of his presidential address, said:—Having had the experience of supplying a section of Greenock with the electric light for a couple of years, I am able to speak somewhat confidently of the possible results of gasworks furnishing electric lighting. In Greenock, I may explain, we fitted up two dynamos, each equal to 100 incandescent lamps of 20 candle-power; and they were driven by a turbine water-wheel and gearing. Only one dynamo was run at a time; but both could have been worked if there had been a demand for the light. The plant was erected on ground belonging to the Water Trust some two miles from gasworks; and it was complete in all respects and provided with necessary testing apparatus. Some 25 incandescent lamps were employed in the streets—being put into the ordinary gas lanterns; and part of a sugar refinery was fitted up with 85 incandescent and two arc lamps. The whole of the mains and cables were carefully laid under skilled supervision, and worked with entire satisfac-

tion. During summer only one man was employed; but in the winter months another was taken on during the daytime, renewing and repairing the lamps, &c. Something like 1,000 yards of cable and 2,500 yards of wires were laid, including branch services to lamps, all put underground. The wires were double lead-covered, having high insulation, safety fuses, and distributing boxes. The district lighted outside the Water Trust ground was about 300 yards long by 100 yards wide. The total outlay on plant was £1,630; wages and working expenses came to about £150 per annum, exclusive of interest, depreciation, cost of supervision, and power. Had these been included, as in the case of gas supply, the expenditure would have been three times this amount. The sugar refinery was fitted up by the proprietor at a cost of upwards of £200 for the 85 incandescent and the two arc lamps. They paid the Gas Trust about £100 per annum for the supply of electricity, and 10s. per week to a man for looking after their lights. The expenses for one year, as estimated by the proprietor—including 5 per cent. on the outlay for wires and lamps, the renewal of the lamps and carbons, the payment to the Gas Trust, wages, &c.—amounted to £175; while their gas account for the portion of refinery lighted by electricity came to about £125. Finding, after a second year's experience, that their expenses were increasing, they decided to give it up and return to gas lighting. The Greenock Police Board, objecting to go on incurring an annual outlay for the few remaining lamps, stopped the experiment. If they could have induced parties to fit up a number of lamps equal to the full power of the dynamos and plant, their yearly expenditure would not have been proportionately increased; that is to say, supposing consumers fitted up the plant within their premises, and maintained it and attended to the renewal of the lamps. It is evident that the electric light cannot be supplied at anything like the cost of gas. Gas is the light of all classes of consumers; but the electric light, from its excessive cost, can only be the luxury of the rich.

As to the advisability of gas companies furnishing the electric light, it must be borne in mind that, from the expensive nature of the plant required, the capital necessary to supply a whole town would be so great as to prevent this being done; and all that an electric light company would do would be to select those parts of a town where there were shopkeepers willing to use it for advertising purposes, or whose stocks were such as would be injured by the products of combustion or the heat of gas, or where there were wealthy people willing to have the light for the novelty of the thing. Where gas is sold as cheaply as it is in most towns, there is no risk of the general adoption of the electric light. The introduction of the light must be so gradual that the natural increase in the consumption of gas which takes place in most towns would prevent its effect on the demand for the older illuminant being injuriously felt.

There is no part of a gasworks plant that can be utilised for the production or supply of electricity. The cost of laying cables from a gasworks to the locality proposed to be supplied would, in most cases, be so large that it would be necessary to erect plant in the immediate neighbourhood of the district. If a gas company were to take in hand the supply of the electric light it would necessitate putting capital into a new business having special plant and skilled labour, and supervision entirely different from a gas business. In order to make it pay active competition with the gas business would be needed; and one need hardly add that this can scarcely be done by those who find it requires all their energies to make gasworks pay, and at the same time provide a cheap and efficient light. In my opinion the supply of electricity should be left in the hands of those companies who specially take in hand such work, and gas companies should no more trouble themselves with it than they would with the supply of oil to those who prefer to burn this illuminant instead of gas—oil being a much more active competitor than electricity.

## EDINBURGH EXHIBITION.

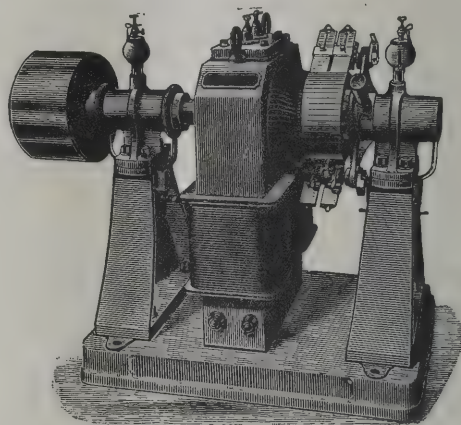
(Continued from page 41.)

*French Electrical Court.*—The interesting collection of exhibits from the Paris Exhibition, for which the French Electrical Court was specially erected, was open for inspection for the first time on the 10th July, and is now almost complete. One side of the building is wholly occupied by the exhibit of the Société Générale des Téléphones, consisting of a very fine collection of instruments, cables, and exchange switchboards. The Administration des Postes et Télégraphes also contributes a number of instruments and specimens of the different cables under its jurisdiction. The Northern of France Railway Company have laid down rails upon which is shown the manner of working railway points electrically, and they also exhibit an electrical capstan for working waggons and turntables. M. Clemancon shows his distribution boards and other specialities for theatres, as fitted by him in five of the Paris houses. There is also to be seen here a section of the Canalisation Electrique Crompton. The Société Cance show a variety of arc lamps ranging from 50 ampères to six, as well as a number of switchboards. The Cance lamps are also to be seen lighting the stand of Messrs. Prentice, Napier & Co. (No. 30). Messrs. Cauderay & Frager have a number of Frager's patent electricity meters suited to various requirements. M. J. O. Mouchel is an exhibitor of his high conductivity copper wire already made well-known in this country by his agents Messrs. Davis and Timmins. Amongst the other exhibitors are Ch. Mildé (bells, indicators, telephones), Richard Frères (electrical and other self-recording scientific instruments), Société Gramme (dynamo, cables), Sautter-Lemonnier (search light).

*Telfer Railway.*—As stated in a former issue this line was opened on the occasion of the visit of the Lord Mayor of London last month. It has been constructed by the Electrical Engineering Corporation (not the Electric Construction Corporation as erroneously printed in our former reference). There are now two trains running, each consisting of 3 carriages, and each carriage is constructed to hold six persons. On the occasion of the visit of the Institution the electric

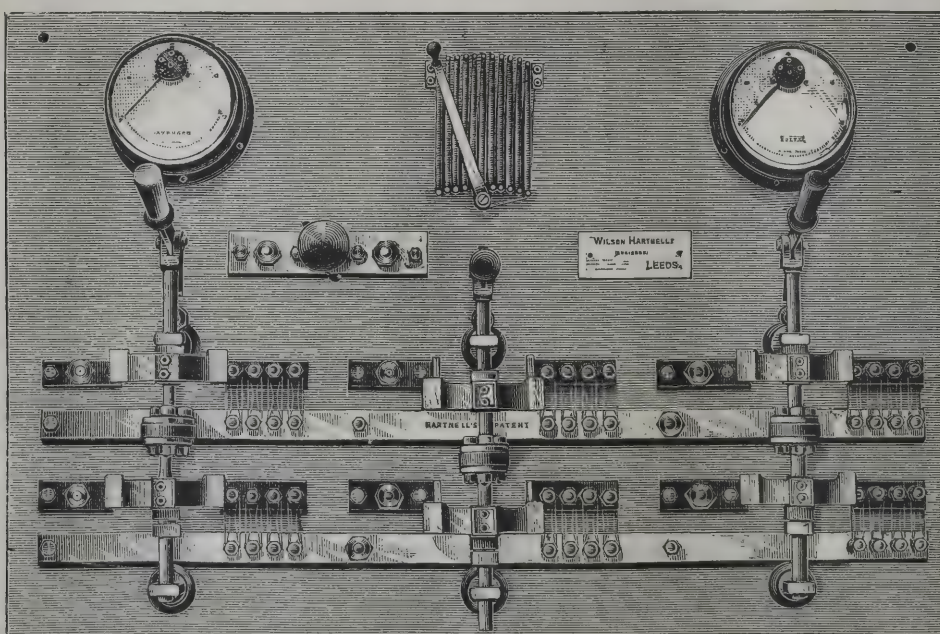
fitted with Hartnell's patent automatic expansion gear. The machine gives 110 volts and 163 ampères at 960 revolutions.

The magnets are made of the softest annealed wrought iron planed all over, and the spindle is  $2\frac{1}{2}$  inches in diameter, running in bearings of ample length. The commutator is exceptionally large and specially suitable for continuous running. The brush adjustments are novel and very convenient. This machine lights up the stand by some 30 16-C.P. lamps and 6 of 100 C.P. each. It also lights up two adjoining stands by an additional 140 lamps.



It also supplies current to a second dynamo or motor which is placed alongside. The output of this latter as a dynamo is 110 volts, 109 ampères at 1,000 revolutions. The current is taken from the dynamo to a distributing switchboard placed on the right hand side against the wooden partition. This switchboard comprises three main switches, Hartnell's patent compound multiple brush contacts, each intended for about 120 to 140 ampères. It is fitted with voltmeter and variable regulator together with ammeter and short circuit plug. This board is so arranged that any one of three dynamos can be put on to any one of three circuits, but the switches are so arranged that it is impossible for an unskilled man to short circuit one dynamo with another.

On the other side is placed a motor switchboard as



railway on the overhead conductor system, in course of construction by the same Corporation, was not ready for business, but it is now running.

No. 70.—Mr. Wilson Hartnell shows one of his latest type dynamos of 18,000 watts, driven by a horizontal steam engine, of Marshall, Sons and Co.,

used in the transmission of power. Both these boards are of the highest class of work and the principle is one which cannot but commend itself to the trade generally. We illustrate a three circuit board made on the same principle as the switchboards actually shown. In this case the installation is composed

of one dynamo only, and the circuits have about 120 ampères on each.

No. 43a.—*Smythe and Payne, Glasgow.*—This exhibit contains specimens of electrical fittings manufactured by Messrs. Fowler, Lancaster & Co., of Birmingham, for whom Messrs. Smythe and Payne are agents in Scotland. There are removable fuses, double and single pole, where the fuse is attached to a short bar of porcelain which can be lifted in and out of the clips which form the contacts, also wall connectors, ceiling roses, switches of different patterns, fuse boxes, bell pushes, &c., and specimens of Messrs. Smythe and Payne's new attachment cut-outs.

In this cut-out the heating effect of the current is employed without the necessary fusing of a wire, the device consisting of a mechanical contrivance for breaking the circuit controlled by a spring weight or other force, and held in check by a cord passed round a bare conductor carrying the current. This cord is made of a material that is readily charred or rendered brittle by the action of heat, so that when the conductor round which it is passed becomes heated by an excess of current this attachment cord gives way, allowing the mechanical contrivance to come into action and break the circuit.

As will readily be seen there is hardly any limit to the different patterns and designs in which this cut-out can be made. A few of them are shown in the figs. 1, 2 and 3, taken from photographs of those exhibited.

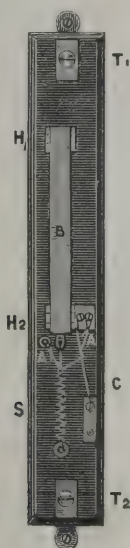


FIG. 1

In fig. 1, which is a narrow or beading pattern, suitable for branch circuits, the current enters at  $T_1$ , passes by the contact holder,  $H_1$ , along the bar,  $B$ , to the holder,  $H_2$ , thence along the conductor,  $C$ , and out at

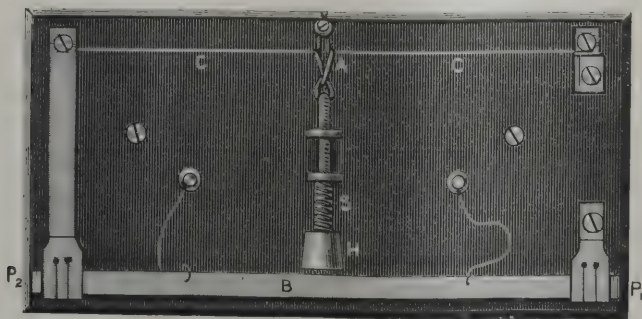


FIG. 2.

the terminal,  $T_2$ . The attachment cord,  $A, A$ , is passed round the conductor,  $C$ , and holds in check the spring,  $S$ ; when it is burnt through by the heating of the conductor it allows the spring to come into action and pull out

the bar,  $B$ , from the contacts,  $H_1$  and  $H_2$ , thus breaking the circuit.

In fig. 2 the contact bar,  $B$ , is knocked out by the hammer,  $H$ , when there is an excess of current. The hammer is held up by the cord,  $A$ , attached to a peg and passed round the conductor,  $C$ ; when the cord is charred by the heating of the wire the hammer descends under the action of the spring,  $S$ , and knocks out the bar from the contact holders,  $P_1$  and  $P_2$ .

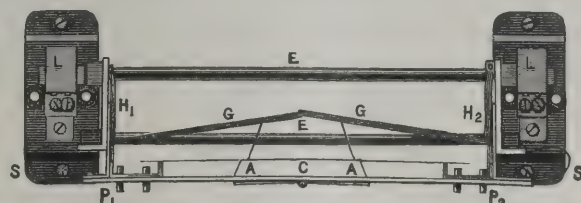


FIG. 3.

In fig. 3 is shown a special form of toggle pattern where the holders are held together by two ebonite rods,  $E, E$ , and fitted into spring clips,  $L, L$ , fastened to insulators on the wall. The cut-out can then be removed without touching any of the metal parts, and another one ready fitted with a cord immediately inserted in its place, or the cord renewed and the same one replaced; this form is suitable for a main cut-out on a high potential circuit. This pattern, like most of the others, can be fitted with small hooks on the toggles and bar, so that cords can be kept ready tied for insertion in the cut-out immediately after one has given way.

The cut-outs are also made with mercury cups, into which a metal bar dips and makes contact in the usual way; this bar is secured to a lever controlled by a spring or weight at one end, and held down by an attachment cord passed round a conductor carrying the current into the cups. When this cord is charred and gives way the spring, or weight, tilts up the lever arm lifting the contact bar out of the cups.

The device is also applied to switches themselves, so as to do away with the necessity of a separate cut-out. Almost any form of switch can be thus rendered automatic, so as to cut off the current if the latter becomes excessive.

After numerous experiments it was found that a gut or horsehair cord made the best attachment. Other materials were tried, including jute, flax, hemp, silk, leather, cotton, &c. The materials prepared to resist the action of water and used for fishing lines were also found to make good attachments. As the gut cords are stronger for their size than the majority of others, they are more suited to stand the constant strain of a spring or weight.

As the wire does not fuse, it will be seen that the same wire can be used over and over again, provided that the cut-out goes off with the same current each time; repeated experiments have found this to be the case, the wire can thus be permanently soldered down on to the switch or cut-out, thus avoiding two screwed contacts.

A platinum wire forms the best conductor, as it does not oxidise, and since it can be used permanently, the disadvantage of its expense is to a great extent overcome.

Where the lead consists of more than one strand, one or more of the strands can be removed, and the remaining ones fastened down to the cut-out to form the conductor, thus doing away with another screw contact, and avoiding the necessity of a separate wire for the cut-out; even a single wire can be thus employed by filing away some of the conductor where the cord passes round it so as to allow that part to become heated before the other parts of the circuit.

In all the experiments conducted, the cord was never seen to catch fire, even when the wire reached redness before the cord was burnt through, as was the case where some fine wires were tried in connection with coarse strings.

The advantages of this form of cut-out and combination switch are briefly as follows :—

It does not require the wire to be renewed every time the cut-out goes off; this renders it useful for ship lighting where string or tackle of some kind is always procurable, which is not the case with fuse wire of the exact size required.

A cord is a simple thing which can be tied by anyone. A considerable number of screwed contacts are done away with, especially where the lead itself is employed.

White hot wires with sputtering of molten metal is done away with. There is less chance of a wire being inserted, which is too large or too small, thus altering the "go off" point of the cut-out.

### EXPERT TESTIMONY AGAIN.

REPORTS on the working of electric tramways are always interesting and serve a useful purpose when drawn up by experts who are thoroughly acquainted with the subject. Two things are essential for the purpose of arriving at a logical conclusion as to whether a new system is as good as, or better than anything that has been done before in a given direction, viz.: Practical experience, and a knowledge of what has been achieved by predecessors. Sometimes an "expert" has either not the time to make himself acquainted with the state of the Art, or the remuneration is not sufficient to allow of the necessary sacrifice of time; under such circumstances it is prudent to refrain from making comparisons. Last week we published a report on the Lineff system, written by Mr. Kapp, who is a great authority on dynamos and transformers, but who, unfortunately, displays some lack of understanding in matters appertaining to electric traction. Mr. Kapp has evidently had no experience in this line, nor does he seem to be acquainted with the statistics published in papers read before scientific societies, particularly those of A. Siemens, Captain Douglas Galton, A. Reckenzaun, F. Sprague, Dr. Bell, Dr. E. Hopkinson, O. T. Crosby, and others. From these he might have learnt a good deal about the energy required for propelling tram-cars; this, with well-constructed appliances, amounts to between 5 and 8 H.P. on each car of the ordinary pattern; but at the generating station, from 10 to 16 H.P. is necessary for successful operation, and it is the same whether overhead conductors, underground conductors, or storage batteries are used. Referring to "economy of working," Mr. Kapp states in his report that: "to propel the same car by storage batteries would require an additional weight of 3 to 4 tons, at an expenditure of about 12 horse-power. Making due allowance for loss of power in charging and discharging cells, I find that the total amount of steam power required at the station would, with storage cars, be about double that required by the Lineff system." We should like to know where, and how, Mr. Kapp learnt that 3 to 4 tons of cells are necessary, for, as a rule, about half this weight is used; also, how he ascertained that storage cars require double the steam power? Surely the toy line, 75 yards long, constructed by Mr. Lineff, did not reveal such data, for the Lineff system certainly does not contain conductors of infinitely small resistance, nor does it remove the effects of gradients, and, least of all, does it exclude the possibility of leakage; thus the *estimated*  $7\frac{1}{2}$  H.P. per car will be found a long way below the mark when a line on a practical scale has to be planned, and we would advise the consulting engineer to double this figure in future, otherwise he will jeopardise the whole business. It is admitted that the power required to energise and propel the electro-magnet on the Lineff car involves an extra expenditure of  $\frac{1}{2}$  to  $\frac{3}{4}$  H.P., therefore it may be assumed, all other conditions being similar, that this system is that much less economical than many other existing electric tramways.

The Lineff method of working with closed conduits is in itself ingenious and sufficiently meritorious; but

notwithstanding Mr. Lineff's long letter to us, and Mr. Kapp's report (mainly appendix), we do not anticipate that any sane person will consider that it solves the problem of electric traction. Professional opinions on toy lines are now, we are thankful to say, almost things of the past, and we look in these days for results obtained from actual work on a large scale; we are glad, therefore, to learn that the Lineff method of working is now considered ripe for practical application.

On the insulation resistance of underground conductors and the properties of insulating materials, Mr. Kapp probably would not pose as an authority; yet, he says, that "if the mechanical strain had developed cracks in the bitumen, there would have been sufficient time for water to percolate in the interval of 26 hours which elapsed between the two resistance tests." Now this is an opinion to which our readers may attach whatever value they please, while we proceed to give an example of actual practice. Some years ago, a genial American invaded this country with an insulating material and a method of laying underground wires, which he thought would revolutionise those in use. The insulator was not bitumen, but it served the same purpose and was employed in a similar manner. Our friend secured a contract for laying about half a mile of his underground system, some 60 wires being embedded in a trough containing his material.

The section was laid in summer, and for a few weeks all went right merrily. Not a fault could be found on any of the wires during a series of daily tests, and the inventor was in high glee and predicted that the same happy state of affairs would obtain at the end of as many years. Unfortunately heavy rain soon ensued and lasted, off and on, for a considerable period, and in the course of several more weeks its effects were felt. First one wire fell off in insulation, then another, and before 6 months had elapsed every wire contained in that section had gone bad. The result was entirely due to water lodging around the insulating material and in due course finding its way to the wires, and this, it must be borne in mind, was in a solid block of material, not in a tube or channel. We might instance numerous other examples, but enough has been said to show that in matters of this kind one must await events and not jump to conclusions on the strength of a day's experience.

### ST. PANCRAS VESTRY.

At a meeting of the vestry held on Wednesday, the report of the Electricity Committee was presented for discussion, with the following recommendations attached :—

1. That the seven tenders herein mentioned be accepted.
2. That during the adjournment of the vestry your committee be empowered to clear the site.
3. That the committee be empowered to accept the guarantees for each contract, and to prepare the necessary bonds.
4. That the Finance Committee be instructed to draw a cheque to the order of Prof. Henry Robinson in accordance with the terms agreed upon between the vestry and Prof. Robinson, dated November, 1889, amounting to £994 12s.
5. That a cheque be drawn in favour of Dr. Hopkinson, President of the Institute of the Electrical Engineers, for £105, for services rendered as consulting engineer.
6. That a cheque be drawn in favour of Mr. W. H. Preece, electrician to the Post Office, for £52 10s., for his advice and report upon the plans, specifications and tenders received.

Mr. SWERT, in moving their adoption, observed that it was not proposed to use high tension currents. With regard to a report that the light had been tried in the clearing house of one of the railway companies, and had turned out a failure, he said the committee had waited on the chief of the department, who informed them that the experiment with both the arc and incandescent lamps had been in every way satisfactory, and that a committee was sitting to see whether the light should be made permanent. It was said that the vestry ought to arrange for the lighting of the parish with some public company; but in that case, they must be prepared to waive their rights for a period of 42 years. As sensible men, they would accept their committee's report. Motive power, which companies in London were not making provision for, was provided for in their installation. The committee had had very elaborate specifications and estimates made. Forty-five tenders had been received, and not the lowest merely had been accepted. They had as far as possible, placed them-

selves in actual communication with the manufacturers. The original amount estimated, £60,000, had not been exceeded, notwithstanding that the price of material—copper for instance—and of labour had risen considerably. The committee had been in communication with the Westinghouse Company, which held the patent for the 3-wire system, and although it was proposed to pay £800 or £900 for it, it would enable the vestry to save considerably. When it was suggested that Dr. Hopkinson was himself interested in the 3-wire system the committee took the plans and specifications to Mr. Preece for independent advice, and, in Mr. Preece's opinion, which was appended to the report, Prof. Robinson's installation was to be recommended. Replying to a member, Mr. Sweet further said that the buildings would be erected under Prof. Robinson's superintendence, and that the price for the mains was inclusive of everything necessary for a complete installation.

Dr. FORSYTH argued that if members would read between the lines they would see that Messrs. Hopkinson and Preece merely said that the continuous system was proper for transmitting the supply within the radius of half a mile, and that for over that distance the alternating system was the proper one. The speaker also said that the storage batteries would be a constant source of trouble.

Mr. SWEET, in reply to Mr. Clements, said the report was agreed to on the 25th July. The reason that the printers were busy was the only one he knew of why it was not placed in the hands of members earlier.

Mr. CLEMENTS asked when it was put into the hands of the chief clerk.

The CHIEF CLERK said it had never been in his hands.

Mr. LAMBLE moved that the matter be adjourned until the next meeting of the vestry. He explained that he did so not out of opposition to the scheme which the vestry had pledged itself to, but because very few members had had time to consider the report.

The motion was put to the meeting, and 23 voted for the adjournment and 28 against. Four members hereupon demanded a division, the result of which was that 29 voted for the adjournment and 26 against. A dispute arose as to whether any specific date had been mentioned by the mover, and

Mr. WILSON moved that the vestry meet on the following Wednesday, to consider the report of the Electricity Committee.

Mr. SWEET said that to adjourn the discussion to the date of their next meeting, viz., the first Wednesday in September, would add considerably to the expenses for interest, &c.

Mr. WETENHALL, as a member of the committee, thereupon tendered his resignation.

Mr. WESTACOTT said he had voted for the adjournment because he considered members should have an opportunity to consider a scheme which involved an expenditure of between fifty and sixty thousand pounds; but he suggested that members should be asked to sign a requisition for a special meeting, to be held next week, to rescind the vote for adjournment, by which time every member would have been enabled to consider the report.

This was agreed to, and in the meantime the vote to adjourn the consideration of the question to the second week in September would stand.

A letter was read from Mr. Lazarus, resigning his seat on the Electricity Committee, and shortly afterwards the proceedings ended.

## NOTES.

**St. Pancras Electric Lighting.**—We have received a copy of the Electricity Committee's report adopted on the 25th ult. Doubts seem to have been expressed respecting the practicability of Prof. Robinson's scheme, and Mr. J. E. H. Gordon appears to have gratuitously submitted a competitive plan. The committee, however, places every faith in the ability of their engineer, and in this view they are upheld by the reports of Dr. Hopkinson and Mr. W. H. Preece. This we are pleased to see, for the committee states that the consideration of Mr. Gordon's estimate was more or less forced upon its members. The following contracts, amounting in all to nearly £52,000, have been recommended:—Kirk and Randall, buildings; Babcock and Wilcox Co., boilers, &c.; Willans and Robinson, engines, dynamos, &c.; the Electric Construction Corporation, switchboards and batteries; Mowlem & Co., trenches for five miles of mains; Clark, Muirhead & Co., conductors for five miles of private and 5½ miles public lighting. We congratulate the committee, and also Prof. Robinson, upon the result of their joint labours, and the latter is doubtless more than satisfied that his elaborate scheme should meet with the approval, in almost every detail, of such experts in electric lighting as Messrs. Hopkinson and Preece.

**Lighting in Breslau.**—The town committee has decided to raise a loan of £50,000 for the purpose of erecting a central station. It is probable that the tender of Messrs. Siemens and Halske will be accepted. This project comprises the immediate erection of a station of 8,000 lamps capacity, with a view to an extension to a total of 30,000 lights. Continuous currents will be used in conjunction with accumulators.

**The Berlin-Warsaw Telephone.**—A telegram from St. Petersburg states that a Franco-Belgian group of financiers has asked for a concession authorising the laying down of a telephone line between Warsaw and Berlin. The first two minutes' conversation are to be charged 2 roubles, and the following minutes 25 per cent. less. If the Russian Government approves these prices, the telephone would, on the expiration of the concession, revert to the State.

**Paddington Lighting.**—We understand that in the Paddington district there are to be between 5,000 and 7,000 incandescent lamps in operation by October 1st, supplied from the Manchester Square station. Firms contracting for wiring houses may take this as a hint.

**Adoption of the Electric Light at Barnsley.**—At a meeting of the Town Council, on Tuesday, it was resolved to accept the tender of the Westinghouse Electric Company to light a portion of the borough at a cost of £17,800.

**New Central Station in Berlin.**—The Kurfürstendamm Gesellschaft, in Berlin, will shortly commence operations at their new central station, which will supply current to light up the district of Grunewald. The glow lamps, for street lighting, will be arranged two in series. The total cost of the station, including plant and buildings, is estimated at £15,000.

**Milan Cathedral.**—A company has been formed in Milan for the purpose of electrically lighting the dome of the Milan Cathedral by a large lamp placed on the topmost portion. We wonder what the dividend will be if the company does not supply light elsewhere.

**The Lineff System of Electric Traction.**—We are informed that the Lineff Electric Lighting and Traction Syndicate, the sole proprietors of the English and foreign patents, have received offers to instal their system on several London and country tramways, and also in Paris, Brussels and Italy. A company will shortly be formed, with a capital of several hundred thousand pounds, to execute the above orders. It may be mentioned as significant of the feeling of tramway companies regarding accumulator traction, that one of the directors of the North Metropolitan Tramway Company recently visited the Chiswick dépôt, and expressed himself highly satisfied with the working of the Lineff system.

**Dynamos.**—The dynamo described in our last issue, and referred to in a previous article, is the type now being manufactured by Messrs. Andrews and Preece, Limited, electrical engineers, Borough Mills, Bradford.

**Lighting of New Town Hall, Portsmouth.**—The Portsmouth New Town Hall, which has cost upwards of £140,000, has a very complete installation of the electric light; tried a few evenings since it proved highly successful.

**Large Turbines.**—Messrs. Thomson, Son & Co., of Dundee, have just received an order for twin turbines, each developing 500 H.P., or combined 1,000 H.P. effective. One wheel of similar size has been at work for some years, and these two are supplemental. The type of wheel is parallel flow, largely on the lines of the Jonval turbine, and the fall is 20 feet. The drive is for a large textile factory abroad.

**Lightning Strokes.**—In the Victorian *Electrical and Telegraphic Journal* we read the following:—The following short, graphic description of a lightning stroke has been sent us by Mr. James M'Carter, of Congupna Road:—"Last Monday night (3rd March), during thunder and lightning, without rain, I 'cut out,' and shortly afterwards was shocked by seeing the office apparently ablaze, and hearing a terrific report, similar to that of a gun, but much louder. I fully expected to find the whole front of the office smashed in, and could hardly credit, on examination, that the only damage done was several of the screw points of arrester fused. The point of one screw was flattened on to the centre plate, resembling a small coin. I scraped this off, and found there was an indent on the earth plate."

**The Hub of the Universe again to the Fore.**—The *Boston Post*, of June 14th, contains a long account of the improved system of the Union Electric Car Company. We are gravely assured that the devices of the Union Electric Car Company enable the storage battery to be utilised with marked success, as experience abundantly proves. This electrical device, covered by broad patent claims, enables the battery to receive back a portion of its electrical energy while the car is in motion by converting the motor into a generator. Whenever the car is slowed, stopped, or is running on a downward grade, the motor generates a current that is conveyed back into the storage batteries and partially replenishes the loss of electricity entailed by propelling the car up grades or on a level road. Tests have shown that on the Beverly road the maximum return is more than is taken out at any one time. This return current has never before been produced by a series-wound motor, and it is accomplished by charging the field magnets from a supplementary battery. The comparatively small amount of electricity required to run the cars of the Union Electric Car Company, combined with this process of automatic recharging while in transit, make the use of storage batteries perfectly feasible, while the weight of the car with the batteries in place is 1,000 to 2,000 lbs. less than the ordinary electric car operated by the overhead system. The only thing to be done in England now that the Union Company recovers more than is taken out of the battery at any given time, is to seek permission to use the system. Holroyd Smith, Reckenzaun, Elieson, Lineff, &c., are not within miles of this result.

**Poole and White, Limited.**—On Saturday last week the *employés* of this company took their first annual excursion. The party, which numbered over 30, met at the Elephant and Castle Hotel, Pangbourne, Mr. J. Tryon, the chairman of the company, presiding. The chairman, in proposing the toast of "The Firm," referred to the success which had attended their efforts during the first six months of their existence, and said it was due in great measure to the excellent *esprit de corps* of the *employés*. It was the desire of the directors to establish a reputation for the excellence of their work, and to extend and increase their business and profits by legitimate trading, and not by means of mere financing, and he was pleased to see the way in which every one in the business did their utmost to attain that end. In coupling the toast with the name of Mr. White, he paid a graceful compliment to the ability and zeal with which Mr. White had devoted himself to the interests of the company. Mr. Heaven, who occupied the vice-chair, proposed the toast of "The Board of Directors," to which Mr. Poole suitably replied.

**National Art Competition.**—The exhibition of the works submitted for the National Art Competition, 1890, by the schools of Art throughout the kingdom, was opened to the public on Monday last, and will remain open until the end of August. The works will be on view in the Enamels Gallery of the South Kensington Museum. The free days are Mondays, Tuesdays, and Saturdays, when the museum is open from 10 a.m. to 10 p.m.

**Royal Jubilee Exhibition, Manchester, 1887.**—At the final meetings of the Executive Committee and Guarantors' Council, held prior to their dissolution in December last, the following gentlemen were appointed trustees to hold the surplus funds until all outstanding claims were adjusted, and to hand the net balance over to the Whitworth Institute—viz., Sir Joseph C. Lee, Messrs. C. J. Galloway, Oliver Heywood, and William Agnew. A meeting of the trustees was held last week at the secretary's offices, 46, Brown Street, Manchester, when a final statement of accounts was submitted, showing the net cash surplus to be £41,942 18s. 11d., or, together with the value of certain assets not realised, and which have now been handed over to the institute, £43,492 18s. 11d. A cheque for this amount was drawn and handed to Mr. Oliver Heywood for presentation at the meeting of the institute. The affairs of the exhibition were then declared to be finally closed.

**Lightning in an Engine Room.**—The engine house containing the dynamos which furnish the Viceregal Lodge, Simla, with the electric light, was recently struck by lightning during a storm. At the time there were in the room two native workmen, with Mr. Jordan, the European superintendent. One of the men was struck down, but was brought round immediately afterwards by a plentiful application of cold water; the other man did not fall, but received a severe shock. The lights in the engine house all went out, and the place was in darkness for a short time. Some pieces of mica used in the lightning guard were pierced, and the fastenings torn away.

**The London Press and the Proposed Telegraph Subsidies.**—The *Leeds Mercury*, in a recent issue, comments strongly on the fact that the London daily Press has refused to publish a very important communication deprecating the proposed subsidy to the Eastern Telegraph Companies. We think, with our contemporary, that the incident reflects little credit upon British journalism.

**Improved Fluids for Primary Batteries.**—Mr. Theophilus Coad has invented yet another fluid made of the following ingredients:—Nitric acid, mercury, carbonate of potash, carbonate of soda, bichromate of potash, sulphuric acid, common soda and water. A correspondent writes:—"Where is the patent in this? It is as old as the hills."

**Electric Light Undertakings.**—In the new edition of the "Gas and Water Companies' Directory," published by Messrs. Hazell, Watson and Viney, an electric lighting section has been added, consisting of useful information relating to municipal authorities, companies, and private firms supplying electrical energy for lighting purposes. The following particulars are given of no less than 55 undertakings—name and town, address, date of formation, capital employed, system, capacity of works, price per unit, name of secretary, name of electrician in charge, and area of district supplied. The table appears to have been compiled with care, and the details given must be of interest to almost every one engaged in electrical business.

**Removal.**—The business of telephonic engineers hitherto carried on at 26, Red Lion Square, under the title of The Electric Telephone Company, is removed to Hermitage Works, Richmond, Surrey, where it will henceforth be carried on by Mr. Ernest J. Gillett.

**A Use for the Phonograph.**—A use for Colonel Gouraud's pretty toy has been found at last, and in Arthur Law's new farcical play, "The Judge," the cries of a real infant recorded by the Edison phonograph, on Monday, the 21st ult., are reproduced. The Stage has utilised from time to time most of the contrivances invented in the field of electric lighting, and its adoption of the phonograph adds still another instance of the manner in which scientific progress may be turned to profitable account in the World of Art.

**Consulting Electricians.**—It is very evident that some standard is necessary to which the consulting electrician can adhere, for the unwritten laws of professional etiquette seem quite inadequate. It appears that there are several individuals in existence professing to give advice in electrical matters who are not averse to acting in a manner which should certainly bring them under the serious displeasure of the Institutes to which they belong. What can be thought of any man who, when called in to advise a client who had already arranged to have his requirements carried out by a firm of electrical engineers, coolly says that he (the client) could effect his purpose more cheaply by allowing his professional adviser to hire his own men, and buy the necessary plant for completing the work; and, as if this were not bad enough, he also accepts commissions all round from the firms who supply the goods. We are assured, on unmistakeable authority, that this kind of procedure is being practised, so, how can the *bonâ fide* technical expert, who is ready to give his impartial opinions for a reasonable fee, expect to stand a chance against men who undercut him in the way of payment for professional services, and make up the rest by commissions? One might think that the person requiring technical aid would be cute enough to see through malpractices of this nature, but it appears that such is not the case.

**Electric Railway Conduits.**—We have received a letter from Henry James Peddie giving a description and illustration of his "conduit rail" for electric tramways. The communication is marked "private," yet he concludes by requesting us to notice his invention in the REVIEW. We can only say that the design is a very neat arrangement, without possessing much novelty, and that under more favourable circumstances we should probably have reproduced his drawings. As it is, we refer those interested to Specification 6359, 1890.

**Gas and Electric Lighting on the Continent.**—The European Gas Company, which has always taken a place in the front rank of continental gas companies, during the past year only had an increase in their sales of gas of  $1\frac{1}{2}$  per cent. Enlarging upon this at the meeting of the shareholders last month, the Chairman (Mr. H. McL. Backler), pointed out that this was the aggregate increase at all the stations, but in some cities the increase was more. At Havre, for instance, the increase was at the rate of 4 per cent., but it was a remarkable thing, he added, that at that station there was much more electric light used than at any other. This was not, however, the only instance, but he had observed the same thing in other continental towns. He saw that at Milan, the consumption of gas exceeded that of former times, although in no city in Italy with which he was acquainted was the electric light used to so considerable an extent. He remarked the same thing in connection with Vienna, Berlin and other cities.

**Varley's 1876 Machine.**—This dynamo, which was the rock on which the Anglo-American Brush Corporation split in the recent compound-winding case, is now to be seen in the Edinburgh Exhibition, and will no doubt be an object of the greatest interest to electricians visiting the place.

**More Demonstration.**—On Thursday last week another demonstration was given of the Lineff method of electric traction over the 75 yards of experimental track at the dépôt of the West Metropolitan Tramway Company, Chiswick.

**New Patents.**—Mr. Swinburne has applied for a patent (see p. 142) apparently for five distinct objects. We have hitherto been under the impression that to make inventions valid it was necessary to confine a specification to one object only; perhaps, however, the word "jellygraph" is sufficiently comprehensive to include all the rest.

**Dr. Duncan's Motor.**—Says the *Electrical World*:—"We are now enabled to give some details of the performance of the experimental machine (Dr. Duncan's motor), which give it unquestioned place as one of the most remarkable developments of dynamo-electric machinery. It weighs 1,100 pounds, and in spite of the fact that its armature is solid cast iron, it develops 10 horse-power at the marvellously low speed of 90 revolutions per minute, and accomplishes this feat with an electrical efficiency of 92 per cent. The commercial efficiency was not measured, but as only 25 lbs. of iron are subject to hysteresis, and at a comparatively low rate of reversal, the losses from this cause should be small." How is it known that the motor actually develops 10 H.P., and why has the commercial efficiency not been calculated if brake tests have been applied?

**The Ferranti Mains.**—We hear that part of the main route of the London Electric Supply Corporation is up again in the West End, through the failure of the joints in the new Ferranti cables.

**The Telegraph Clerks.**—We regret to learn that the application of the new scheme is attended with much delay and uncertainty. The vague and ambiguous notices posted in the Central Telegraph Department, to which we referred in a recent issue, have been withdrawn. Interviews with the officials do not seem to be productive of anything definite or satisfactory, and, as several points of vital interest to the staff are still unsettled, a policy of procrastination and mystery is not calculated to have a beneficial or conciliating effect on those interested.

**Tudor Accumulators.**—The well-known manufactory of Messrs. Müller and Einbeck, at Hagen, Westphalia, has been converted into a limited company, with a capital of £225,000. The entire capital has been taken up by the Allgemeine Elektrizitäts Gesellschaft of Berlin, Messrs. Siemens and Halske, and the vendors (Messrs. Müller and Einbeck), in equal parts. The chief office will be situated in Berlin. The Hagen firm, which manufactures the Tudor accumulator, appears to have been very successful commercially, and a German contemporary states that the reason why the Berlin houses have joined it is for the purpose of expanding an existing and prosperous business rather than have to enter into competition with it.

**The British Association.**—We have received a circular containing the names of members of the various local committees, and the arrangements for excursions, to which special attention will be paid at the forthcoming visit of the association to Leeds.

**Dissolution of Partnership.**—The partnership between Messrs. W. D. Ramsay and Cecil Walker, electrical engineers, at No. 1, Prince's Mansions, Victoria Street, Westminster (Ramsay and Walker) has been dissolved by mutual consent.

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## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

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**Western Counties and South Wales Telephone Company, Limited.**—At an extraordinary general meeting of this company, held at the Grand Hotel, Bristol, on the 30th May, the following special resolution was passed:—"That the articles of association be altered as follows: (a.) By striking out the word 'United' wherever it occurs in Articles 38, 39, 74, 83 and 93, and in sub-clauses of Article 71, and substituting the word 'National' therefor, and by striking out the figures £30,000 in sub-clause (A) of Article 71 and substituting £50,000." The resolution was confirmed on the 27th June and filed July 1st.

The annual return, made up to the 13th June, was filed 26th July. The nominal capital is £400,000, divided into 200,000 preference shares of £5 each and 300,000 ordinary of £1 each. The shares taken are 20,000 preference and 281,197 ordinary. Upon 16,600 preference shares the full amount has been called, and the full amount is considered to have been called and paid upon 3,400 preference and 281,197 ordinary. The calls paid amount to £76,233, including £10 paid on 20 shares forfeited. The unpaid calls amount to £6,777.

**New Cadogan and Belgrave Electric Supply Company, Limited.**—The registered office of this company is now situate at 91, Manor Street, Chelsea.

**Taunton Electric Lighting Company, Limited.**—The registered office of this company is now situate at St. James Street, Taunton.

### NEW COMPANIES REGISTERED.

**Plymouth and District Pulsion Telephone Company, Limited.**—Capital £4,600, in £1 shares. Objects: To acquire a license of the patent rights granted to Lemuel Millett (1888, 9th June, No. 8,457) for improvements in a mechanical telephone known as the Pulsion telephone. Signatories: W. W. Ricksend, 200 shares; A. Jackson, 40 shares; T. Emerson, 200 shares; A. Latimer, 10 shares, all of Plymouth; Wm. Square, 14, Portland Square, 200 shares; F. A. Buckle, B.A., Stoke, 200 shares. The signatories are to appoint the first directors. Qualification, 100 shares; the company in general meeting will determine remuneration after 10 per cent. dividend has been paid. Registered 24th ult., by Sir Joseph Causton and Sons, 9, Eastcheap.

**Edison Phonographic Toy and Automaton Company, Limited.**—Capital, £300,000, in £1 shares. Objects: To acquire certain patents for the application of the phonograph to dolls, toys, and automatic figures. Signatories (with 1 share each): E. J. Cook, 28, Pelham Road, N.; J. Guthrie, Florinda Villa, Lancaster Road, Leytonstone; F. B. Liley, 100, Sundmere Road, Clapham; J. H. Coulson, 76, Oakley Road, N.; S. Cooke, 53, Chadwick Road, Peckham; E. J. Newbatt, 57, Cowley Road, Brixton; G. Bridgland, 8, Sparham Road, Brixton. The first directors are Major-General Sir J. W. Campbell, Bart.; H. G. Hemmerde, T. H. Lambert, Col. A. D. Campbell, and Louis Swaley. Qualification, 250 shares; remuneration, £250 per annum each, with £50 additional for the chairman. Registered 26th ult., by Collette and Collette, 2, Victoria Mansions.

**British Gas Lighting Improvement Company, Limited.**—Capital, £160,000, divided into 6,000 preference shares of £5 each, and 130,000 ordinary shares of £1 each. Objects: To carry on the business of mechanical, gas, and electric engineers and manufacturing chemists in all branches. Signatories (with 1 preference share each):—H. S. King, 65, Cornhill; W. J. Wright, Montagu Mansion, W.C.; F. W. Clark, C.E., South Norwood Park; A. C. Trotman, 12, Thayer Street, W.; J. V. Miller, 39, Stockade Road, Clapham; A. Gooch, 69, Benthall Road, N.; G. Chandler, Woodford. The first directors are:—J. Boustead, Malcolm Guthrie, H. Wollaston Blake, W. L. Hammack, and H. S. King, C.I.E. Qualification, £100 in shares. Remuneration, £200 per annum each, with an additional £100 for the chairman. Registered 28th ult., by Paine, Son and Pollock, 14, St. Helen's Place.

**Mulholland, Maugham and Company, Limited.**—Capital £5,000, in £10 shares. Objects: To take over the business of R. M. L. Mulholland and B. Maugham, at Ferryhill, Durham, trading as Mulholland, Maugham and Co., and to manufacture and deal in apparatus and things required in connection with electrical engineering, and in particular to construct and lay down cables. Signatories (with 1 share each): R. M. L. Mulholland, P. Mulholland, B. Maugham, T. Iseton, J. Sanders, all

of West Cornforth; J. Parker, East Howle; J. W. Mulholland, Hatton, Warwick. The signatories are to appoint the first directors. Qualification, £500 in shares or stock; the company in general meeting will determine remuneration. Registered 29th ult. by Bell & Co., 9, Bow Churchyard.

### CITY NOTES, REPORTS, MEETINGS, &c.

#### Telephone Company of Austria.

Mr. Henry Grüwing presided at the seventh ordinary general meeting of shareholders, held at the company's offices, 53, New Broad Street, yesterday.

The report states:—There has been expended on capital account a further sum of £10,155 11s. 10d. The gross receipts from all sources were £16,524 8s. 8d. After providing for all expenses, including £5,425 4s. 2d. for debenture interest and dividend on preference and interim dividend of 2½ per cent. on ordinary shares, and £3,932 0s. 9d. for royalties and taxes to the Austrian Government, there remains a balance of £1,640 12s. 7d. which, with the amount £3,284 4s. 6d. brought forward from last year, leaves to the credit of profit and loss account for the current year the sum of £4,924 17s. 1d.; of this amount it is proposed to place £3,900 to reserve, and to pay a further dividend of 1½ per cent. upon the ordinary shares (making 4 per cent. for the year), leaving £1,047 2s. 7d. to be carried forward to the next year's accounts.

The Government trunk line between Vienna and Prag, which was alluded to in the last report, was successfully completed and opened for the use of the public towards the end of last year. The undertaking has proved a very great success, and, although the outlay to this company for new switchboards, &c., was considerable, we have reaped the benefit of a fair increase in the number of new subscribers joining the exchange system.

The Austrian Government have now in contemplation the connecting up of other towns worked by this company on the same terms as the Vienna-Prag line, i.e., the Government constructs the trunk line and places the company's exchange subscribers in communication with Vienna, the company having the indirect benefit of the increase of subscribers.

In relation to the prolongation of the company's concessions, the Minister of Commerce has fixed the month of October for opening the negotiations, which, your directors have every hope, will be of a satisfactory nature to the shareholders.

The cordial and satisfactory relations of the Imperial-Royal Telegraph and Postal Authorities and of the municipal bodies with the company remain unaltered.

The Chairman said the progress of the company had been satisfactory during the past financial year, and since the commencement of the current year a further satisfactory increase had taken place, as compared with the corresponding period, of 17,430 florins. He congratulated the shareholders that the year under review was the first of the company's existence in which it had been in a position to declare a dividend on the ordinary shares. It was not that no profits had been made in previous years, but that the necessities of the capital account had been so pressing that every penny of the surplus profits had had to be invested in extending the business. They would now, he did not doubt, reap the benefit of that policy. Their parent, the Consolidated Company, had now made arrangements to supply them with capital to any reasonable amount. He did not doubt that the negotiations pending with the Austrian Minister of Commerce, for the extension of the company's concessions, would have a satisfactory issue. He moved the adoption of the report and accounts, and to declare a dividend on the terms of the report.

Mr. Fitzgerald seconded the motion, which was carried unanimously. Mr. R. E. Bateman was re-elected a director, and Messrs. Deloitte, Dever, Griffiths & Co. auditors of the company; and, with a vote of thanks to the board, the proceedings came to a close.

#### Elmore's Patent Copper-Depositing Company, Limited.

A MEETING of this company was held at Cannon Street Hotel on Monday. The Chairman (Mr. Carson), apologised for the absence of the president of the company. The directors were very glad to be able to meet the shareholders with an excellent record of progress, shown in the following report:—

"Your directors have pleasure in submitting to you the annexed statement of the company's accounts for the period from the date of the company's formation on January 18th, 1889, to June 30th, 1890.

"In March last, the board disposed of the exclusive British license for the manufacture of wire to Elmore's Wire Manufacturing Company, Limited. The shares of this company (£2 each), were issued at a premium of £1, half of which, in addition to the sum of £75,000, went to our own company. The issue was made to about 500 applicants. A total sum of £105,000 has been received from the wire company, and, in addition, our own company has a further interest contingent upon the allotment later on of the balance of shares of the first issue. Our own company holds"

also, all the founders' shares, which are entitled to one-half the profits after 20 per cent. has been paid to the shareholders of the wire company. The board regard these founders' shares as a most valuable asset. It may here be stated that the wire company have received an offer from a strong group of Birmingham firms to take their whole output of wire spirals at remunerative prices.

"The board recommend that out of the sums above-mentioned, an immediate distribution be made of 10s. per share, less income tax, which, with the interim dividend of similar amount paid in April last, makes a total distribution equal to 50 per cent. on the paid up capital for the period named.

"The sum of £20,000, being the estimated original value of the patents for the manufacture of wire, has been reserved, and will be invested or employed in the company's business, as may be deemed most expedient. A further amount of £4,584 8s. 3d. is carried forward, after setting aside £35,000 for the second dividend referred to above."

## BALANCE SHEET, 30th June, 1890.

Dr.	£	s.	d.
To nominal capital—			
100,000 shares of £2 each £200,000, of which there has been issued 70,000 shares, fully paid	140,000	0	0
„ sundry creditors	7,992	12	8
„ amount received on forfeited shares	7	10	0
„ balance brought forward from profit and loss account	39,584	8	3
	£187,584	10	11

Cr.	£	s.	d.
By purchase of patents (£100,000). Less amount reserved from sale of license (£20,000)	80,000	0	0
„ buildings, siding, and wharf	8,011	18	8
„ plant, machinery, loose tools, &c.	11,339	1	1
„ furniture and fittings	199	3	8
„ sundry debtors on open accounts	391	0	4
„ Elmore's Wire Manufacturing Company, Limited	2,111	10	0
„ sundry investments	1,600	3	0
„ cash at bankers	73,763	19	11
„ stocks in trade—			
Raw material	7,714	10	4
Sundry stores	603	3	11
„ preliminary expenses	1,850	0	0
	£187,584	10	11

## TRADING AND PROFIT AND LOSS ACCOUNT, from 18th January, 1889, to 30th June, 1890.

Dr.	£	s.	d.
To sundry purchases, wages, and general charges, after deducting stock of raw material and sundry small sales	3,200	6	9
„ maintenance of patents, legal, and professional charges	465	5	6
„ rent, rates, taxes, and insurance	306	2	6
„ income tax	875	0	0
„ stationery, printing, and advertising	166	2	1
„ directors' fees	2,082	7	0
„ balance carried down	77,825	1	4
	£84,920	5	2

To interim dividend of 10s. per share, less tax, paid 18th April, 1890	34,125	0	0
„ directors' percentage of profits under Clause 72 of Articles of Association	4,115	13	1
„ balance carried to balance sheet	39,584	8	3
	£77,825	1	4

Cr.	£	s.	d.
By amount receivable to date in respect of sale of license to Elmore's Wire Manufacturing Company, Limited, less expenses of the formation of that company, (£103,928 5s. 9d.); deduct amount transferred to patents account (£20,000)	83,928	5	9
„ interest	785	0	5
„ transfer fees, &c.	206	19	0
	£84,920	5	2
By balance brought down	£77,825	1	4

The Chairman briefly referred to the various items specified in the report. He attributed the great profits made to the change of policy of the board. They would have been at work much sooner had they acted upon the original plan of having the works at Sheffield; but they discovered that their process was capable of large development, and they would require a large amount of land in order that new work could be carried on alongside the parent company, and under the same management. With that view, they obtained a most suitable site at Leeds. The progress of the works

was retarded for several weeks last summer by a strike in the building trade. Further delay in commencing work was caused after the issue of the circular to shareholders, dated February 3rd, 1890, by the breakdown of the first engine supplied for the purpose of driving the dynamos used for depositing. The engine was supplied by a firm of the highest reputation, but had nevertheless proved a complete failure, no useful work having ever been done by it, and it was still incomplete in the hands of the makers, who had undertaken to replace it with an entirely new engine. The breakdown of this engine prevented the management for a period of several weeks from gaining the experience on a large scale with the plant and machinery in the first section of the works, which the board considered indispensable before committing the company to further outlay of capital. The only difficulty experienced subsequently to the breakdown of the engine had been in obtaining perfectly balanced cast iron mandrels or cores for depositing tubes upon. The difficulty had now been fully overcome. The board, however, had now the pleasure to report that everything was proceeding satisfactorily at the works. Two new engines have been delivered, and have been working well for several weeks. The various patent appliances have been tested, and have been proved to work with the utmost regularity. The board consider that the promises held out by the inventors, both as to quality of material and cost of manufacture, have been amply fulfilled. Tubes and wire manufactured on a commercial scale by the company have been submitted to users and experts, and have given the utmost satisfaction, the results being in every case equal to those obtained from samples manufactured in the laboratory, and referred to in the prospectus. At the present time the state of the works is as follows:—Complete offices, laboratory and stores have been provided. A workshop large enough for a 20-ton per week depositing plant has been erected and fitted with engines, machinery and tools. Engine power and dynamos have been provided for depositing 15 tons a week—boiler power for 25 tons a week—and engine and boiler houses, factory chimney, and copper melting furnace have been built on a scale sufficient for the whole works, and for eventual extensions up to 50 tons a week. In addition, a siding connecting the works with the Midland main line has been made. A wharf has been constructed on the canal. The entire property has been walled-in and drained, and two cottages erected. Nothing now remains to be done but to complete the new depositing shed, which will turn out 15 tons per week, and to provide the necessary additional engine power, dynamos, and depositing tanks. The whole of the 20-ton per week depositing plant is in process of completion, and the first section, capable of turning out 5 tons a week, has been satisfactorily at work for several weeks. The works are fitted with the electric light throughout, and an ample supply of copper purchased at prices considerably below the present market quotations has been provided. The demand for the company's products is far in excess of this 20-ton plant, and the prices obtainable are most remunerative. Now that the work connected with preparing for the two exhibitions is over, the whole of the available plant is engaged in the execution of orders.

Several shareholders were dissatisfied that there was not a sufficient sum placed to the reserve, and an amendment was proposed, which was, however, defeated.

A shareholder commented strongly on the defective engine supplied, and considered there was little excuse.

All the members of the board were re-elected, as were the auditors.

## Direct United States Cable Company, Limited.

THE twenty-sixth ordinary general meeting of the company was held at Winchester House on the 25th ult., when the report (printed in our last issue) and balance sheet for the six months ending June 30th, 1890, were produced.

The Chairman, Sir John Pender, K.C.M.G., said the revenue for the half-year, after deducting out-payments, amounted to £40,017 1s.; working and other expenses, including income tax, but excluding cost of repairs of cables, amounted to £17,616 5s. 8d., leaving a balance of £22,401 as the net profit of the half-year, making, with £8,318 brought forward from the previous half-year, £30,718 14s. 8d., which had been appropriated thus: interim dividend of 3s. 6d. per share for the half-year ending March 31st, 1890, amounting to £10,624 5s., and a proposed final dividend of 3s. 6d. for the half-year ending June 30th amounting to £10,624 5s.; transfer to reserve fund £8,502; balance forward £968; total £30,719. The revenue for the earlier portion of the half-year showed some falling off as compared with the corresponding period, the tariff being 1s. in each case, but in the latter months an improvement took place which more than recouped the previous falling off, and resulted in a small increase of £390. The reserve fund, after deducting £4,919, cost of repairs, and crediting it with £4,389, interest on investments, and profit on sale of securities, and with £8,502 transferred from the revenue account, amounted to £250,000. The investments were, as heretofore, considered to be worth more than the figure standing in the balance sheet. At their last meeting he expressed the opinion that six months hence it would be necessary to draw special attention to the reserve fund. That fund had been drawn upon to some extent to supplement the company's dividends, and to maintain the 3½ per cent., which otherwise could not have been paid with the 6d. tariff. On the present occasion it would not be necessary to appeal to the shareholders in any way in connection with the reserve fund. It seemed to have turned the corner; they had for the first time during the last two or three years been

adding to instead of taking from it, until it was increased to a very nice round sum. By carrying out the principle laid down, of adding the interest to the reserve fund, and also such a sum as could be conveniently spared from the income, he hoped the company would eventually be placed in a thoroughly independent position, and he believed it occupied such a position that day. He believed their cable stood at a very much lower cost than any other cable in the Atlantic, and that with this large reserve fund no other company could compare with it in value. Standing as it did at, comparatively, a very small price, it was, at any rate, just as good as any other cable in the Atlantic standing at three or four times the price. It was in such good order that the duplex system could be worked upon it. Practically, therefore, the company had the command of two cables, and he was very pleased to say was doing its full share of the Atlantic traffic. As the pool was at present, there was an impression abroad that a single cable was a very dangerous investment. However, when he told them that the cable was one of seven in the Atlantic, they would understand that if the company's cable became incapacitated for twelve months, it would not interfere in the slightest degree with the company's income, as the other cables would be quite sufficient for the traffic; or if the company's cable should be incapacitated for two years, the shareholders would still have an income, and even if it became incapacitated for three years, they would still have a small income. Let it be distinctly understood that if the company stood as a single cable, it was nevertheless guaranteed by six others. That was a very strong position to occupy, and, taking it in connection with the reserve fund, he looked upon the company's cable as the cheapest in the Atlantic. A fault occurred the other day, it was very difficult to repair a fault under £5,000; and it was a consolation to think that these faults were not owing to any real decay of the cable, but were caused by the anchors of fishing boats. The directors had done all they could to induce fishermen when they took up the company's cable, to drop it; they had even undertaken to find them new gear, and in the past few years, although cables had been broken in this manner, the company had received a good deal of consideration on the part of the fishermen. It had always been the directors' policy when a break occurred, not to hesitate in sending out a ship, in whatever weather, to repair it, and the company had been singularly prompt with its repairs. The directors considered it to be the company's duty to the pool to do a fair and full share of the work, and he believed they were doing their fair proportion of it at present. It was encouraging, if not so much so as he could wish, that at the present moment, with a shilling tariff, the company carried as many messages as it did with a sixpenny tariff. Still it was not earning the amount of money such a risky operation entitled it to; but he hoped that by some combination or arrangement material economies might be made which would enhance the company's dividend. They must endeavour to work this out somehow—he was not prepared to say how. Still it was a magnificent property, and while it was necessary that these submarine cables should be efficiently worked, it would be a reflection on all concerned if they could not arrange in some way to give a fair return to their shareholders out of what had become a great political and commercial necessity. The directors would always bear in mind that a company like this should be just as well as generous. The pool was probably stronger than it ever had been. Regarding the Telegraphic Conference, he was pleased to say that while the company's cable had not been very much under consideration, it had nevertheless been fairly considered by the other companies, and its demands had been settled upon a basis which ought to be satisfactory to all. It had, at any rate, lost nothing by the conference. In conclusion, he assured the meeting that if by any possibility their old dividend of 5 per cent. could be recovered, they might depend upon the board doing its utmost to bring about that result. He moved the adoption of the report and accounts, and to declare a final dividend of 3s. 6d. per share, free of income tax, making with the interim dividend already paid, a total of 3½ per cent. for the year ending 30th June, 1890.

The motion was seconded by Mr. Ford, and unanimously agreed to.

Messrs. Charles Meara and E. M. Underdown were re-elected directors, and Messrs. J. G. Griffiths, F.C.A., and John Sawyer, F.C.A., were reappointed auditors.

A vote of thanks to the board, and one of sympathy with the chairman in his recent bereavement, were unanimously carried, and the proceedings terminated.

### Manchester Edison-Swan Company, Limited.

The eighth annual meeting of the shareholders of this company was held on Monday at Manchester, Mr. V. K. Armitage, chairman of the company, presiding.

The Chairman, in moving the adoption of the report, said the directors were not as satisfied as they might be with the result of the year's operations. Instead of making something over 10 per cent., as they did last year, they had only made something over 5 per cent. They had worked just as hard in making the 5 per cent. as they did last year in making 10. The real fact was that at this moment there was a manifest falling off all over the country in the demand for small separate installations. There was no doubt whatever that the electric lighting would increase enormously in the near future, but their strong impression was that the increase would be in lighting from central stations. Parliament had been issuing provisional orders for central stations broadcast all over the country, and there could be no doubt that

many people who wished to have the electric light were now waiting to see what would be the outcome of these provisional orders. Before they went to the expense of securing private plant they were waiting to see whether they could not draw their supply of electric light from a central station, as they did now in the case of gas. At the same time he had not the smallest doubt that in the near future there would be an enormous increase in the electric lighting industry, and with the experience the Edison-Swan Company had had in this district, and with the name they had acquired for doing good work, he had not the smallest doubt that when the increase came the company would receive at least its fair share of the work that had to be done.

The motion for the adoption of the report was seconded by Mr. I. C. Waterhouse, and carried unanimously.

On the motion of the Chairman, seconded by Mr. Waterhouse, it was further resolved that the profit of £1,647 6s. be appropriated to payment of a dividend at the rate of 5 per cent. per annum (£1,000), carrying forward the balance of £647 6s.

Sir Joseph C. Lee and Mr. I. C. Waterhouse were re-elected directors of the company; and Messrs. Jones, Crewdson & Co. were reappointed auditors.

### The Edison and Swan United Electric Light Company, Limited.

THE seventh annual report of this company (printed in our last issue) was presented to the shareholders at the meeting held in the Cannon Street Hotel, on Monday, the 28th ult., Mr. J. Staats Forbes presiding.

The Chairman said it was one of the most embarrassing reports he had ever had to deal with. As it needed no apology, he was scarcely at home with it. He was old enough to remember when the meetings of the Edison and Swan were not quite of this character, because the results were not quite so satisfactory. Good wine needed no bush. The report itself was exceedingly brief; the facts were chiefly to be found in the figures, which he would deal with somewhat generally. The important item, of course, was the profit and loss account, and the important part of it was that the balance to its credit, after making every fair and proper deduction, was the very respectable one of £61,115 3s. 3d., enabling the company to devote it, if the meeting approved, to the full payment of 7 per cent. upon the capital, and a very considerable contribution in respect of those years, which were sadly too long, when, he remembered, there was no dividend to pay. They knew that the dividend upon the ordinary stock to the extent of 7 per cent. per annum was cumulative, i.e., in the years when it was not secured by the profits any balance would be carried forward as a claim on the future. Last year was the first in which they had been able to devote a portion of the profits to wiping out arrears. This year he was happy to say they were able to devote a much larger sum for that purpose. Beginning on the debtor side, the stock on hand brought forward on the 1st of July, 1889, was £25,985 18s. 2d. He reminded honourable proprietors that the character of the business demanded that a very large amount of capital should be locked up in stock. These lamps were of great variety in form and power, and a great many people had very different ideas as to the voltages and the form they needed; and in order to be in a position to supply the demand, the company must have a very large and various stock on hand. On the opposite side of the account there was a very large increase—from £25,985 18s. 2d. to £56,266 8s. 10d. He would say at once that only a very small proportion of it was attributable to the increase in lamps, it having kept pace almost in arithmetical proportion with the increase in sales. A very large portion of the increase was due to purchases of platinum, which, with a certain amount of forecast, the directors had availed themselves of the opportunity of buying at prices which now, he feared, were very considerably exceeded. That platinum was carried into the account at cost price, and was held in reserve. In round numbers, that would account for some £25,000. The demand for platinum was increasing, and the supply did not appear to keep pace with the demand. Putting two and two together, the directors thought the price might go up, and had, therefore, laid in a considerable amount. For wages, purchases, &c., there was an item of £73,719 2s. 1d.; cost of conducting the business, £13,915 19s. 9d.; depreciation of plant, £1,838 17s. 9d.; and, on the other side, sale of lamps, fittings, &c., £118,865 15s. 1d.; interest on investments, £1,442 17s. 1d.; stock in hand already adverted to, £56,266; balance, £61,115 3s. 3d. The proposed appropriation was a very simple one. On one side was the balance of profit, £61,115 3s. 3d., and on the other what was proposed to be done with it. There was the dividend for the year ending 30th December, 1889, at 7 per cent. per annum, £12,371 14s. 7d. of which had been paid as interim dividend, and which amounted to £24,743 9s. 2d., and there was the claim upon the further profit. The accounts were kept from year to year, and the debt against each year wiped out, beginning with the more remote. The directors proposed to pay the balance of the cumulative preference dividend on the A shares, for the year ending 30th June, 1884, at the rate of 4 per cent., and that payment not having exhausted the balance, they proposed a further payment on account of cumulative preferential dividend on the A shares at the rate of 4 per cent. for the year ending 30th June, 1885. With that they had still £8,093 9s. 5d., which they proposed to carry to the reserve fund. Taking next the reserve capital account, there was no substantial alteration observable.

The capital was exactly as in the last account; the only figure affected was that under B shares. Those shares were entitled to one-fourth of the profits, after payment of a cumulative preferential dividend of 7 per cent. per annum upon the A shares. The preferential cumulative dividend of 7 per cent. amounted, on the 30th June, 1890, to £110,609 17s., the balance amount remaining to be wiped out of future profits amounting to £26,257 5s. 5d. There were sundry credit balances, a reserve fund of £4,595 10s. 10d., which, if the shareholders confirmed the resolutions which would be presented to them as to dividends, would be further increased by £8,093 9s. 5d. On the opposite side of the account they had an item of £235,614 9s. 3d., cost of patents, goodwill, preliminary outlay, loss on working, &c., as per last balance sheet. That had been from time to time subject to diminution by writing down realisation of property and so forth to the extent of £2,030 15s. 6d., against which there was a sum of £2,439 5s. 1d., as further expenditure incurred in extension of works or other purposes only chargeable to capital, and the amount now stood at £236,022 18s. 10d. Then there was the item—amount of "B" shares issued as per contra, £117,820. The shares referred to were those given to Mr. Edison and his friends as the value of their interest in the concern. They were deferred to the others, and some day—he hoped not a distant one—they would come in for a fourth of the profits of the undertaking, after paying 7 per cent. Other assets of the concern were:—Manchester Edison Swan Company, Limited, £100,000 "B" shares, at nominal cost, amounting to £12,000; freehold property, £33,396 9s. 7d.; plant and stock, £77,221 2s. 11d., including the large amount of £56,266 8s. 10d. referred to above; office furniture, £256 17s. 2d.; debtors, £15,203 15s. 11d.; investments, £27,500; and cash at banker's and in hand, £31,563 0s. 6d. Not an inconsiderable amount of the company's capital was that item of freehold property. That property of a going concern, embracing as it did, the lamp factory at Ponder's End, which was bought very cheaply indeed, on which some money had been spent, and which was being extended from time to time, in order to meet a possible very great demand for lamps, was set down at the very safe figure of what had been spent upon it. The item, office furniture, was happily disappearing. The debtors included bad and good. The account appeared to be a tolerably satisfactory one, and the shareholders might feel assured that very liberal allowance had been made on all heads on the debit side, and that the balance was absolutely without charge in respect of any cutting down or holding back of responsibilities which the current revenue ought to bear. He moved the adoption of the report and accounts, and to declare the following dividends:—(a) At the rate of 7 per cent. per annum, upon the "A" shares of the company, for the half-year ending June 30th, 1890, making 7 per cent. for the year; (b) 4 per cent., in completion of payment of arrears of cumulative preference dividend, for the year ending June 30th, 1884; and (c) 4 per cent., in respect of arrears of cumulative preference dividend for the year ending June 30th, 1885, to be distributed in accordance with Clause 87 of the articles of association.

The motion was seconded by Mr. Leyland and carried unanimously.

Mr. Shelford Bidwell was re-elected a director, and Messrs. Welton, Jones & Co. were reappointed auditors.

The Chairman, replying to a vote of thanks to the board, said he believed the reason why the company had emerged from what at one time seemed to be a very perilous position, was the strong conviction which the board possessed that the concern was worth fighting for, and the exercise of a great deal of courage, combined with a good deal of forecast and prudence in insisting upon the rights of the company being upheld. Had the board not felt that it had a proprietary which trusted it entirely, and showed its confidence in it upon every occasion of good and evil report, it might in certain moments of anxiety, when the patents were being fought for, have broken down. It was the shareholders' confidence in the board which kept it going, and he was very glad to think that it had been earned, and that it was continued now that the company was in better and smoother water.

### The Globe Telegraph and Trust Company, Limited.

The seventeenth ordinary general meeting of the company was held on Tuesday, the 29th ult., at Winchester House, to receive the report and accounts for the year, &c. Sir John Pender, K.C.M.G., presided. The report states:—

"The net revenue of the company for the year, after deduction of expenses, amounts to £193,499 4s. 10d., which, with the balance of £2,054 10s. 6d. brought forward, make a total of £195,553 15s. 4d. From this amount there has been distributed the sum of £130,806 5s. 8d. in interim dividends, leaving an available balance of £64,747 9s. 8d.

"The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 4s. 3d. per share on the ordinary shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income tax, upon the preference and 5 per cent. net upon the ordinary shares (against 4½ per cent. for the preceding year), and carrying forward a balance of £118 18s. 6d.

"Since the last report 80 shares of the German Norwegian Company have been drawn for amortisation and paid off at par less exchange. It is probable that this cable may be acquired by the German Government within a short period. £890 stock of the Submarine Telegraph Company has been paid off, at 107 per £100

stock; there is still a small return to be made by the liquidators. £200 of the Société Carmichael has been paid off. A further 350 American Cable Company's (\$100 fully paid) shares with 5 per cent. guarantee of the Western Union Company of New York have been added to the investments.

"The directors record with much regret the loss of their colleague, the late Sir Daniel Gooch, Bart. They have elected Mr. James Pender in his stead.

"In conformity with the articles of association William Ford, Esq., and Sir Henry Daniel Gooch, Bart., two of the directors, retire, but, being eligible, offer themselves for re-election.

"The auditors, Mr. John George Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.), and Mr. William Griffith, B.A., barrister-at-law, also retire at the meeting, and offer themselves for re-election."

The Chairman said, were he to repeat the remarks made by him on the last occasion, they would be quite appropriate to describe the present state of affairs. On that occasion he pointed out that there was a considerable amount of prosperity prevailing in the telegraph system generally. They had terminated their battle in the Atlantic, and were receiving as many messages at the shilling rate as they had previously been at the sixpenny rate; and, of course, their exchequer and, eventually, their dividends had been materially contributed to. During the last three years the company had been steadily progressing, just as the submarine companies had progressed, and to-day it occupied, on the whole, a very satisfactory position. The company during the year received £198,466 4s. 2d., and after deducting working expenses, there was a balance of £193,499 4s. 10d. A sum of £130,806 had been distributed, leaving an available balance of £64,700 for the final dividends, which the directors recommended, of 3s. on the preference shares, and 4s. 3d. on the ordinary shares, or a net dividend of 5s. per share on the ordinary shares, as against the £4 12s. 6d. paid last year. A small balance was carried forward, but the company, being a trust company, was not bound to pay any large amount to the reserve. Taking the combined dividends of preference and ordinary shares during the seventeen years of the company's existence, they found an average dividend of £4 6s. had been paid. The directors hoped to maintain the level of the present year's dividend, viz., 5 per cent. With regard to submarine companies, it might be said the result of the Paris Conference had not been unfavourable. The policy of these companies was the very broad one, not only doing their work well, but so as to satisfy their customers and the general telegraphing public. The other day the British East African Company held a meeting in London, in which some idea of its work was given; but, unfortunately, it was not stated that the Eastern (Telegraph) Company had at its own cost laid down a cable to connect the British East African Company's important port of Umbassa with the still more important one of Zanzibar. That it had done entirely at its own cost, and entirely in the interest of the British East African Company. The policy of the submarine cables was to follow the flag and to follow the trade wherever they found trade and civilisation alongside, so as to help them on. The changes as regards submarine companies had been very few in the last year, and the Paris conference would not materially affect them. One of these companies, the Eastern Extension, had made an arrangement with the Australian Governments to make the very bold experiment of reducing the tariff from 9s. 4d. to 4s. That had been done by the colonial governments guaranteeing the cable companies 50 per cent. of any loss. But the directors of these companies were so confident that the reduction of the rate would double the traffic, that they had not hesitated to take their part in the risk. The policy of the companies was a broad one, and the broader the more prosperous it was; and as the prosperity of the Globe Company was dependent on the success and prosperity of the cable companies, the shareholders might feel confident that what the other companies did would materially benefit their company. Changes in the company's investments had been very few. It had acquired 350 of the American Cable Company's shares. That company was guaranteed by the Western Union Company of New York, and the shares had been bought at a price which admitted of a fair return. The German Government had taken over all the interests the company had in the German Union Company's shares, and these had disappeared from the statement of the company's assets. There only remained the German Norwegian line, which no doubt would ultimately be acquired by the German Government. Having alluded to the loss sustained by the company in Sir Daniel Gooch, Bart., he moved the adoption of the report and accounts, and to declare a dividend of 3s. per share on the preference shares (less income tax) and 4s. 3d. per share on the ordinary shares (free of income tax, already deducted), making, with the former distributions, a total dividend for the year of 6 per cent. upon the preference shares (less income tax) and 5 per cent. net upon the ordinary shares.

The Marquis of Tweeddale seconded the motion, which was carried unanimously, the retiring directors and auditors were re-appointed, and, with votes of thanks and condolence, the meeting dissolved.

### Anglo-American Telegraph Company.

The report of the directors, to be laid before the ordinary general half-yearly meeting of the proprietors, to be held in the Great Hall, Winchester House, 50, Old Broad Street, in the City of London, to-day, at 2 p.m., states:—The total receipts from

the 1st January to 30th June, 1890, including the estimated balance of £2,247 12s. 8d. brought forward from the last account, are estimated at £152,989 7s. 11d. This amount, however, is subject to revision, as the law-suit between this company and the Paris and New York Telegraph Company is still pending. The traffic receipts show an increase of £2,025, as compared with the corresponding period of last year. The total expenses of the half-year, including the new offices in New York, repair of cables, &c., as shown by the revenue account, amount to £53,945 9s. 7d. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary stock, and of 25s. per cent. on the preferred stock, was paid on the 1st May, 1890, absorbing £43,750, and a second quarterly dividend of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, will be paid on the 1st August, 1890, amounting to £52,500, leaving a balance of £2,793 18s. 4d. to be carried forward to the next account. The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the Northern Placentia cable, near Placentia, and of the St. Pierre-Duxbury cable, 270 miles from St. Pierre. The vessel was chartered to the Direct United States Cable Company on two occasions for executing repairs, the remuneration for which will be found in the revenue account. The company's cables and land lines are in good working order. Three new offices have been opened in New York, viz.: No. 8, Broad Street; 16, Beaver Street; and 446, Broome Street. The results are encouraging. No progress has been made since the last report in the litigation between the Anglo-American Telegraph Company and the Paris and New York Telegraph Company, the appeal to the Conseil d'Etat not having come on for hearing. The agreement between the Société du Cable Transatlantique Français (amalgamated with the Anglo-American Telegraph Company in 1873) and the Submarine Telegraph Company, for the laying, maintenance and working of the cable used by this company from Brest to Salcombe expired on the 31st March, 1889. The French and English Governments bought the Submarine Telegraph Company's property, with the exception of the cable above referred to, and, after long negotiation, this company has purchased the Brest-Salcombe cable from the liquidators of the Submarine Telegraph Company for the sum of £2,000, and by arrangement with the associated cable companies this company now maintains and works the cable for an agreed annual payment, which forms a charge upon the joint purse receipts.

### The Chili Telephone Company, Limited.

The first annual report of the directors, for the year ended March 31st, to be presented at the meeting of shareholders at Winchester House, on the 8th August, states:—

The whole of the 40,000 shares offered in August last were subscribed for and allotted, and the full sum of £5 has been since received on each share. The purchase money of the properties in Santiago, Valparaiso, Concepcion, Iquique, Chillan, Talcahuano, Talca, Pisagua, Serena, Coquimbo, Tomé, Penco, Coronel, and Lota, has not yet been paid in full to the vendors. The transfer of these properties was, in due course, made to this company by the vendor company in America; but some shareholders of that company, resident in Chili, obtained an injunction to restrain the legal registration of the transfer, with the view apparently to secure to themselves a larger proportion of the vendor company's assets than would fall to them upon a *pro rata* division with the shareholders in America. The action in the Chilean court is between the vendor company and a small minority of its shareholders. This company is not a party to it, but the board has used, and is using, its best endeavours to remove the impediment to the legalisation of the transfer. Negotiations are reported to be pending to settle the differences by compromise or arbitration; either mode would raise the injunction, and allow registration to be completed. After much correspondence and considerable loss of time, the vendor company appointed this company's general manager in Chili to be the general manager of the vendor company there, and, consequently, since that appointment the business has been conducted without serious inconvenience. The business has been carried on for this company since 1st May, 1889, and the net profit to 31st March, 1890 (after providing for the extraordinary depreciation in currency) amounts to £5,520 8s. 1d. The directors recommend a dividend of 2s. 6d. per share, being a fraction more than at the rate of 5 per cent. per annum from the time the capital has been received to the 31st March last. This will leave £520 8s. 1d. to be carried forward to the account of the next year. The business is progressing satisfactorily.

	1st May, 1889.	31st March, 1890.	Increase.
The number of Subscribers was ...	2,070	2,868	798
The gross revenue was at the rate per annum of ...	\$225,357	\$300,346	\$74,989
The mileage was ...	2,523	3,320½	797½

The above increases were during 11 months only. The general manager in Chili has every confidence that, in the current year, very much more favourable results will be shown, and his estimate of improvement is confirmed by a continuous and rapidly increasing demand for telephones. Negotiations have lately been opened for the sale to this company of the property, plant, and business of the National Telephone Company of Chili (National Co. Telefonos Chile), in Santiago and Valparaiso, and the directors have been advised by cablegram of the purchase of the whole for £36,000.

That company was the only competitor with this company, and the directors having now, practically, the control of the telephone business in Chili, anticipate that the company's revenue will be considerably increased; while the requirements of the public will be fully met by necessary extensions and moderate and more uniform charges. In accordance with the articles of association, the Hon. F. Ernest Allsopp and Mr. Thomas Greenwood retire from the board of directors, but, being eligible, offer themselves for re-election. The auditor, Mr. Thomas A. Welton, also retires, and offers himself for re-election.

### Spiel's Petroleum Engine Company.

An extraordinary general meeting of the company was held on the 29th ult. at the offices, Leadenhall Buildings, 11, Leadenhall Street, for the purpose of explaining the present position of the company.

Major J. Heritage (the chairman) stated that an end had been put to all litigation, and questions between the company and Messrs. Shirlaw & Co., who had surrendered the exclusive licence held by them, and the company were fortunate in having come to arrangements with Messrs. Clarke, Chapman & Co., engineers, of Gateshead, whose licence would, however, not be an exclusive license. The company was free to grant licences to other people, with one exception. Messrs. Clarke, Chapman & Co. attached considerable importance to having the exclusive right of manufacturing the installation machines, and that had been given them. The prospects of the company were now much more promising. He moved that the directors be paid £250 per annum, and whenever a dividend of 10 per cent. or upwards shall be paid, an additional 10 per cent. upon the net profits.

Mr. R. A. Tiessen seconded the resolution.

Mr. Neal moved as an amendment that the resolution should stand adjourned for 12 months, in order that a statement of accounts, showing the exact position of the company, might be presented.

Mr. G. Williams seconded the amendment.

Several shareholders expressed a doubt if the company had money in hand sufficient to pay the directors if the resolution was agreed to; but eventually the amendment was negatived.

### The Maxim-Weston Electric Company, Limited.—

An extraordinary general meeting of the Maxim-Weston Electric Company, Limited, will be held at Winchester House, Old Broad Street, in the City of London, on Thursday next, for the purpose of considering and, if deemed expedient, passing the subjoined extraordinary resolution which is intended to take effect under Sub-section 3 of Section 129, of the Companies Act, 1862, "That it has been proved to the satisfaction of this meeting that the company cannot by reason of its liabilities continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily." Should the resolution be duly passed, a further resolution will be proposed at the same meeting for the appointment of a liquidator or liquidators for the purposes of such winding up.

**The Schanschieff Electric Light and Power Company, Limited.**—Creditors of this company are to send their names and addresses and particulars of their debts or claims, to Messrs. S. de Lissa and H. A. Campbell, care of Richard Rabbidge, 32, Poultry, London, on or before 4th August next, or to be excluded from any distribution made before such claims are sent in.

**The Patent Electric Fire Lighter Company, Limited.**—It has been decided to wind up the company voluntarily under Companies Acts, 1862 to 1867. Mr. W. J. Finch, of 21, Osborne Road, Broadstairs, is the liquidator. The assets of the company will be sold to a new company called the New Electric Fire Lighter Company, Limited, partly for cash and partly for debentures.

**Woodhouse and Rawson Electric Supply Company of Great Britain, Limited.**—The petition for the winding up of this company, presented by Major Goodrich Holmsdale Allfrey, of Wakefield Park, Mortimer, Berks., will be heard before Justice Stirling, on Saturday, the 2nd August.

**Elmore's Patent Depositing Company, Limited.**—Application has been made to the committee of the Stock Exchange to appoint a settling day and grant a quotation to this company.

**The West Coast of America Telegraph Company.**—The directors have declared an interim dividend of 3s. per share for 1890.

**Chili Telephone Company, Limited.**—The directors in their report to March 31st last, recommend a dividend of 2s. 6d. per share, leaving £520 to be carried over.

### TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending July 26th, amounted to £4,750.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 26th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,679.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 24).	Closing Quotation. (July 31.)	Business done during week ending July 31, 1890.	
					Highest.	Lowest.
£						
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	97 — 100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50 — 51	49½ — 50½	50	...
2,725,420	Do. do. 6 p. c. Preferred ...	Stock	86 — 87	85 — 86 xd	87½	85¾
2,725,420	Do. do. Deferred ...	Stock	14 — 14½	13¾ — 14½xd	14½	13½ <sup>5</sup> / <sub>16</sub>
130,000	Brazilian Submarine Telegraph, Limited ...	10	11½ — 12	11½ — 12	11½	11½
99,000	Do. do. 5 p. c. Bonds...	100	102 — 104	102 — 104		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416...	3	1½ — 2	1½ — 2		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 1½	1½ — 1½		
\$7,216,000	Commercial Cable, Capital Stock ...	\$100	103 — 105	103 — 105	105	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	5 — 5½	5 — 5½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½xd		
16,900	Cuba Telegraph, Limited ...	10	12¾ — 13½	12¾ — 13½	13½	...
6,000	Do. do. 10 p. c. Preference ...	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	3½ — 4	3½ — 4		
6,000	Do. do. 10 p. c. Preference ...	5	9 — 10	9 — 10	9½	...
60,710	Direct United States Cable, Limited, 1877 ...	20	10½ — 10½	10½ — 10½xd	10 <sup>7</sup> / <sub>16</sub>	10 <sup>3</sup> / <sub>16</sub>
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000 ...	10	14 — 14½	13¾ — 14½xd	14 <sup>5</sup> / <sub>16</sub>	14
70,000	Do. 6 p. c. Preference ...	10	15 — 15½	15 — 15½xd	15 <sup>7</sup> / <sub>16</sub>	15 <sup>3</sup> / <sub>16</sub>
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 — 111	108 — 111		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock ...	Stock	106 — 109	106 — 109	108½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½xd	14 — 14½	14½	14
320,000	Do. 6 p. c. Debentures, repay. February, 1891 ...	100	101 — 103	101 — 103		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 — 106	103 — 106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 — 106	103 — 106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 — 103	100 — 103	101	100½
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000 ...	5	4½ — 5½	4½ — 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5½ — 6	4 — 4½xd	5½	5½ <sup>1</sup> / <sub>16</sub>
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ... (£3 only paid)	5	2 — 2½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited ...	10	9½ — 9½	8½ — 9½	9½ <sup>5</sup> / <sub>16</sub>	9½ <sup>1</sup> / <sub>16</sub>
180,042	Do. do. 6 p. c. Preference ...	10	15½ — 15½	14½ — 15½	15½	14½ <sup>5</sup> / <sub>16</sub>
150,000	Great Northern Tel. Company of Copenhagen ...	10	15½ — 16½	15½ — 16½	16	15¾
40,900	Do. do. 5 p. c. Debs. (issue of 1881) ...	100	100 — 103	100 — 103	102½	...
250,009	Do. do. (issue of 1883) ...	100	105 — 108	106 — 109		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18½ — 19½xd	18½ — 19½	18½ <sup>5</sup> / <sub>16</sub>	18½
200,000	Do. do. 4½ p. c. Deb., 1896...	100	103 — 105	102 — 104		
17,000	Indo-European Telegraph, Limited...	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited ...	10	6 — 7	6 — 7		
100,000	Do. do. 6 p. c. Debentures ...	100	107 — 110	107 — 110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	4½ — 4½	4 — 4½		
436,700	National Telephone, Limited, Nos. 1 to 436,700 ...	5	5 — 5½xd	4½ — 5	5½ <sup>1</sup> / <sub>16</sub>	4½ <sup>5</sup> / <sub>16</sub>
15,000	Do. 6 p. c. Cum. 1st Preference ...	10	12 — 12½xd	12½ — 12½	12½	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10½ — 10½xd	10 — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	¾ — ¾	¾ — ¾		
9,000	Reuter's, Limited ...	8	7¾ — 8½	7¾ — 8½		
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 } Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	{ 1 5 }	{ ¼ — ... 2½ — 3½ }	{ ¼ — ½xd 2½ — 3 xd }		
20,000	Submarine Cables Trust ...	Cert.	112 — 116	112 — 116	114	...
3,381	Swan United Electric Light, Limited ... (£3½ only paid)	5	5 — 5½	5 — 5½	5½ <sup>5</sup> / <sub>16</sub>	5½
78,949	Telegraph Construction and Maintenance, Limited ...	12	43 — 45 xd	42 — 44	43¾	42½
150,000	Do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
55,000	United River Plate Telephone, Limited ...	5	4 — 4½	4 — 4½xd		
146,000	Do. do. 5 p. c. Debenture Stock...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109 ...	10	9 — 10 xd	9 — 10	9½	...
300,000	Do. do. 5 p. c. Debentures ...	100	99 — 102	100 — 103	101½	100
30,000	West Coast of America Telegraph, Limited ...	10	5¾ — 6¾	5 — 6 xd	6½	5½
150,000	Do. do. 8 p. c. Debs, repay. 1902 ...	100	106 — 110	106 — 110		
64,572	Western and Brazilian Telegraph, Limited ...	15	10½ — 10½	10 — 10½	10 <sup>5</sup> / <sub>16</sub>	10½
26,986	Do. do. 5 p. c. Cum. Preferred ...	7½	6½ — 7	6½ — 7		
26,986	Do. do. 5 p. c. Deferred ...	7½	3¾ — 4½	3¾ — 4½		
200,000	Do. do. 6 p. c. Debentures "A," 1910...	100	106 — 109	106 — 109		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 — 107	104 — 107		
88,321	West India and Panama Telegraph, Limited ...	10	2½ — 2½	2½ — 2½	2½ <sup>1</sup> / <sub>16</sub>	2½
34,563	Do. do. 6 p. c. 1st Preference ...	10	11 — 11½	11 — 11½	11½ <sup>5</sup> / <sub>16</sub>	11½
4,669	Do. do. 6 p. c. 2nd Preference ...	10	12½ — 13½	12½ — 13½	13	12¾
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
179,300	Do. do. 6 p. c. Sterling Bonds ...	100	99 — 101	99 — 101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 1½	1½ — 1½		

\* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7¾.—Electric Construction Corporation (£10 paid), 7¾—8¼.  
Elmore Copper Depositing Priorities, 5½—6½.—Elmore Wire, ¼ dis—par.—House-to-House Company (£5 paid), 5 — 5½.—London  
Electric Supply Corporation, Ordinary (£5 paid), 1¼—2.—Manchester Edison and Swan Company, £9, (£1 paid), 12/- — 14/-.

## COUNTY COUNCIL AND ELECTRIC LIGHTING.

ON Tuesday last, at the final meeting of the London County Council before the vacation (Sir John Lubbock in the chair), Mr. F. B. Westacott, as Chairman of the Highways Committee, reported that they considered that it would be desirable for the Council to authorise them to deal during the coming vacation with any matters within the scope of their reference which might require immediate action on the part of the Council. The Council was aware that it possessed extensive powers under the Electric Lighting Orders and Acts, which might have to be exercised before it reassembled, and other matters might arise requiring immediate attention. Should this authority be given, the committee proposed to report to the Council, at the first meeting after the recess, what, if anything, had been done under it. They recommended, and the Council resolved:—"That the Highways Committee be authorised to deal, during the ensuing vacation, with any matter within the scope of their reference, which may require immediate action on behalf of the Council."

The same committee reported that they had considered a notice (registered No. 97), dated 16th July, 1890, from the London Electric Supply Corporation, of intention to lay distributing mains in Stanhope Street and Park Lane, as shown upon a plan submitted with the notice. The proposed works were of the same kind as those of this company previously approved by the Council; and the committee recommended: "That the sanction of the Council be given to the works referred to in the notice (registered No. 97), dated July 16th, 1890, of the London Electric Supply Corporation, upon condition that the company do give three days' notice to the Council's engineer before commencing the works; that the mains be laid under the footways, and be kept 9 inches below the underside of the pavement, wherever it is found to be practicable; and that where the mains cross carriage-ways they be kept at the same depth below the concrete."

This was agreed to.

The Parliamentary Committee reported as follows: "We understand that another Electric Lighting Confirmation Bill is to be introduced, and that it will contain orders affecting the City of London. We were authorised on the 3rd June last to present a petition against any order which does not comply with the Council's resolutions of the 28th January and 22nd April, 1890, and we have authorised the preparation and presentation of petitions in the event of any of the orders not complying with the above-mentioned resolutions. We recommend: "That the employment of two counsel be authorised to support the petitions, if necessary." This recommendation was approved.

## LEGAL.

**Gibbs and Others v. Ferranti.**—This appeal came before the Lord Chancellor, Lord Herschell and Lord Morris, in the House of Lords last Thursday. It was an appeal against an order of the Court of Appeal affirming an order of Mr. Justice Kekewich, by which it was ordered that the Gaulard and Gibbs Patent, No. 4,362, A.D. 1882, should be revoked.

Mr. ASTON, Q.C., and Mr. J. C. Graham appeared for the appellants; and Sir H. Davey, Q.C., and Mr. Moulton, Q.C., for the respondent.

The patent was granted in 1882 for an alleged invention of a new system of distributing electricity for the production of light and power by secondary generators, the invention being described as consisting in "the employment of an alternating current produced by an electro-dynamo machine, and determining by its passage through an unlimited number of induction coils of special construction the creation of induced currents, whose quality and value depend solely upon the construction of the said induction coils." In 1886 the respondent presented a petition for the revocation of the patent, and the appellants thereupon applied to amend their specification by disclaimer, and the specification was accordingly amended. The Court of Appeal held that the effect of the amendment was to alter the nature of the invention for which the patent had been originally granted, and therefore revoked the patent.

Their LORDSHIPS affirmed the decision of the Court below, and dismissed the appeal with costs. Judgment affirmed and appeal dismissed with costs.

**The International Cable Company, Limited.**—The petition of Alfred Sohler Bolton, a member of a large firm of wire manufacturers at Cheadle, for the winding up of the International Cable Company, Limited, was again before Mr. Justice Stirling on Saturday. Mr. Graham Hastings, Q.C., having stated the case for the petitioner on the 19th inst.

Mr. BUCKLEY, Q.C. (with whom was Mr. John Chester), replied on behalf of the company. He said that his lordship had already delivered a judgment in this matter by which, of course, he was bound. The petitioner was a member of a firm of wire manufacturers, and had taken 1,000 shares in the expectation that he would be repaid by a contract for wire for the company. In the former decision his lordship came to the conclusion that the main

object of the company was that stated in clause A of the memorandum of association, viz., to establish, maintain and work lines of telegraphic communication between the Azores and points on the coast of Canada and elsewhere. Now, his observation upon that would be this:—Clause A was not to work lines of telegraphic communication under a particular concession, but was to work particular lines of telegraphic communication. His lordship came to the conclusion that the real and primary object was to work the concession from the Portuguese Government, which had been referred to in the prospectus. What his lordship thereby held was that the object of the company was to establish, maintain and work lines of telegraphic communication between this country, Portugal and the Azores; and the question now was—Had that object become impossible, in the sense that this company could not carry it out, and was one shareholder, not supported by others, entitled to say the business had become so impossible that he was entitled to the winding-up order, although the other shareholders did not agree with him, and although no meeting had been called to consider whether this course should be followed or not. Admitting, for the sake of his argument, that the date had passed, the Portuguese Government had neither declared the concession forfeited, nor had they expressly continued it. But, on the 5th inst., a measure to allow, promote, and support by a subsidy the laying and maintenance of a cable from Lisbon to the Azores was passed; and his evidence was that Signor Cavallo, who was largely interested in this company, and who had great influence with the Portuguese Government, expected to obtain the concession under this measure, and would be willing to transfer it to this company. The object of the company, therefore, was, he submitted, not impossible.

Mr. WARRINGTON, for 3,410 shares, which he said represented £34,100, supported the petition.

His Lordship, without calling on Mr. Hastings to reply, said he thought that the order must now go. On the evidence now before him he was perfectly satisfied that the original concession granted by the Portuguese Government, on the faith of the existence of which the shares were subscribed, was completely gone, so completely that a new law had been passed by the Portuguese Legislature authorising a new concession altogether. His view was that this company was formed to work that original concession, and, though the objects of the association were not limited to that particular concession, still that particular concession was mentioned in the prospectus, and by the terms of the prospectus a large portion of the capital was to be appropriated to carrying out that particular concession. That concession was gone. All that now appeared was this; there was a suggestion that the Portuguese authorities were likely to grant the new concession (which by the recent legislation, they had been authorised to grant), to Signor Cavallo, who was said to be willing to transfer that concession to this company. But all that was mere speculation. It was mere speculation that Signor Cavallo would obtain the concession at all, and secondly it was mere speculation that if he did get it he would transfer it to this company. All that could be said was that after the delay which had taken place Signor Cavallo had expressed his willingness—he had not entered into a binding agreement—to transfer it to the company if the Portuguese Government yielded the concession to him. It seemed to his Lordship that there was no reasonable prospect of any such concession being obtained, and, therefore, it was useless to continue this company.

His Lordship accordingly made a winding-up order in the usual form.

**Edison & Swan Co. and Others v. Bayley Bros.**—This case came on last Saturday, in the High Court of Justice, before Mr. Justice Stirling.

Mr. ASTON: Would your lordship allow me to mention what will be a very short matter. It is the case of the Edison & Swan Co. v. Bayley, in which I am instructed to say that it has now been arranged between the parties that an order shall be taken on the terms that the defendants shall submit to a perpetual injunction, pay the costs, and take a license. Then I apply to your lordship, supposing this meets with your approval, for a certificate that the particulars of breaches are reasonable.

Mr. JUSTICE STIRLING: I am not going to try whether the particulars of breaches are reasonable, or certify anything about it. I know nothing about it; but if you agree, I agree.

Mr. LEVETT: I appear for the defendants, my lord, and I cannot say that the particulars are unreasonable.

Mr. JUSTICE STIRLING: Very well then; take it by consent.

Mr. ASTON: If your lordship pleases.

**The Lightning Conductor Controversy.**—The *Western Electrician*, of Chicago, has published the writings of both Dr. Lodge and Mr. Varley on this subject. The editor, as is the case with Mr. Varley, cannot reconcile himself to the statements of Dr. Lodge, that "iron is as good or even better than copper for the purpose of conveying currents alternating with extreme rapidity," and that the extra resistance of a thin iron wire, used as a lightning conductor, has advantages over those offered by a thick copper rod. We draw the attention of both disputants to another article on the same topic which appeared in our last issue.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

“The Working Efficiency of Secondary Cells.” By W. E. AYRTON; C. G. LAMB, E. W. SMITH and M. W. WOODS, Associates. Read at Edinburgh, Wednesday, July 16th.  
(Continued from page 110.)

The following table gives a *resumé* of these results, all the discharges being made with 10 ampères until the P.D. fell to 1·8 volts per cell, and all the charges being made with 9 ampères until the P.D. per cell rose to 2·4 volts. Before each rest the cells were charged until the P.D. per cell was 2·4 volts.

Discharge.				Charge.				Percentage efficiency.	
Duration of discharge.	Ampere-hours.	Watt-hours per cell.	Number of curve	Duration of charge.	Ampere-hours.	Watt-hours per cell.	Number of curve.	Quantity.	Energy.
Cells in Normal State.									
h. m. 10 12	101·9	201·7	8	h. m. 11 38	104·5	230·7	9	97·2	87·4
Rest of 10 days. Cells then charged and discharged many times until brought to a steady working state.									
10 0	100	196	10	11 31	103·8	228·2	11	96·4	85·8
Rest of 12 days. Cells then charged and discharged many times until brought to a steady working state.									
9 8	91	176·7	12	10 45	96·8	213·2	13	94·1	82·8
Rest of 16 days. Cells then charged and discharged several times until brought to a steady working state.									
8 24	82·6	161·3	14	9 36	86·2	190·5	15	95·8	84·7
Rest of 16 days. First discharge and charge after rest.									
5 41	56·6	110·5	16	7 54	71·1	158·3	17	Ratio of first discharge after rest to last charge before rest. 65·4 58·0	
Cells now charged and discharged several times until brought to a steady working state.									
8 0	80	156·9	18	9 20	83·8	184·6	19	Ratio of first discharge after rest to first charge after rest. 79·6 69·6	
Rest of 16 days. First discharge and charge after rest.									
5 21	53·3	104·1	20	6 30	58·5	123·3	21	Ratio of first discharge after rest to last discharge before rest. 63·6 56·4	
Cells now charged and discharged several times until brought to a steady working state.									
7 6	76	149·5	22	8 12	78·3	173·5	23	Ratio of first discharge after rest to first charge after rest. 91·1 81·1	
Cells now charged and discharged several times until brought to a steady working state.									
7 6	76	149·5	22	8 12	78·3	173·5	23	97·1	86·3

From the preceding table it will be seen that, in spite of the continued charging and discharging at the end of each rest, there is a steady falling off in the quantity capacity from 101·9 ampère-hours at the beginning to 76 ampère-hours at the end, and in the energy capacity from 201·7 watt-hours to 149·5 watt-hours. The quantity and energy efficiencies, 97·1 and 86·3 per cent. respectively, at the end are the same as at the beginning. Comparing the first discharge after each of the 16 days' rest with the last charge before the rest, there appears to be a loss of about 36 per cent. in the ampère-hours, and about 43 per cent. in the watt-hours; or, since the normal quantity and energy efficiencies for a discharge immediately following a charge are respectively 97 and 87 per cent., it follows that the rest of 16 days causes a loss of about 33 per cent. in the ampère-hours, and about 30 per cent. in the watt-hours, in addition to the losses that normally occur on a charging immediately followed by a discharging.

From all that precedes, it follows that the previous history of an accumulator produces an enormous effect on its efficiency. If, for example, an E.P.S. accumulator be over and over again carried round the cycle of being charged up to 2·4 volts per cell and discharged down to 1·8 volts per cell, the charging and discharging currents being the maximum allowed by the makers—viz., 0·026 ampère per square inch in charging, and 0·029 ampère per square inch in discharging—the “working efficiency” thus obtained may be 97 per cent. for the ampère-hours and 87 per cent. for the watt-hours. If, on the contrary, the cell be constantly charged up before being tested, then for the first few charges and discharges between the above limits, and with the same current-density in charging and discharging, even the energy efficiency may be as high as 93 per cent.; whereas, if the accumulator has been left for some weeks, then, although it was left charged, the energy efficiency for the first few charges and discharges will be as low as 70 per cent.

While, on the one hand, our tests show that continued rests

of a charged accumulator appear to be far more serious for the accumulator than we had previously imagined, the working efficiency appears to be higher than has hitherto been supposed, since we believe that about 84 per cent. efficiency in the watt-hours is all that the advocates of accumulators have claimed for them.

The smallness of the first discharge after a rest might be due either to a kind of electric short-circuiting and dissipation of the energy, or to some change in the character of the active material converting the energy perhaps directly into heat, or to some of the active material having become disconnected from the plates during the rest, and having fallen down to the bottom of the cell. The smallness of the first charge subsequently to the first discharge after the rest, shows that mere electrical leakage during that time has not been the cause of the loss of energy, while the steady increase in the storage capacity brought about by a series

of charges and discharges tends to show that rest brings about some change in the nature of the active material.

In all the tests in which the results are given in the preceding table, the charge and discharge were, as already stated, terminated when the P.D. per cell reached a fixed value; it is, therefore, possible that the apparent falling off in the capacity of the cells to store energy may be due to a change in the resistance of the cells produced by the rest. For a change in the resistance of the cells will change the terminal P.D. for a given current flowing through the cells without there being any necessary change in the storage capacity.

It is, therefore, interesting to study the variations in the shapes of the P.D. curves, 8 to 23. First, as regards the charge curves, 9 and 11 are convex everywhere to the axis of time, except just when the charging is commenced; whereas 13, the steady working charge curve after the second rest, rises much more rapidly when the P.D. cell is about 2·3 volts than is the case in the other two curves, then bends over and becomes concave to the axis of time. This peculiarity in curve 13 is, we notice, not very striking in the small reproduction of this curve in the text, but in the original curves, as plotted on large sheets of squared paper from the results of the tests, the difference between curves 11 and 13 is very noticeable.

The following list gives the time in hours and minutes from the commencement of the charging when the P.D. per cell reaches 2·2 volts:—

Curve 9 ... 7 h. 14 m. ... Steady working charge before rests.  
  “ 11 ... 7 h. 32 m. ...   “   “   “   after first rest.  
  “ 13 ... 7 h. 10 m. ...   “   “   “   “   second rest.  
  “ 15 ... 5 h. 36 m. ...   “   “   “   “   third rest.  
  “ 17 ... 3 h. 54 m. ... First charge after fourth rest.  
  “ 19 ... 5 h. 43 m. ... Steady working charge after fourth rest.  
  “ 21 ... 4 h. 50 m. ... First charge after fifth rest.  
  “ 23 ... 4 h. 40 m. ... Steady working charge after fifth rest.

It is clear, then, that the effect of a series of rests is to cause the P.D. to rise much more rapidly in subsequent charges, and the time curve rise of P.D. still remains unusually steep, although at the end of every rest there was a prolonged and uninterrupted series of charges and discharges.

Curves 16 and 20, which give the values of the P.D. for the first discharges after the fourth and fifth rest, show that for the first hour from the beginning of each of these discharges the P.D. rises instead of falling, as is the case in normal discharges.

If the rapid fall of P.D. at the commencement of a discharge be due to a disappearance of gases occluded in the plates, as some have supposed—or if, as Dr. Gladstone and Mr. W. Hibbert imagine, the charging of a cell causes the acid round the positive plate to become denser than that round the negative, and the mixing of the denser and less dense acid at the commencement of the discharge causes the P.D. to fall—then the absence of this fall at the beginning of a discharge after a long rest would be explained; but neither of these theories would apparently explain the rise of the P.D. obtained by us at the commencement of a discharge after a long rest. Indeed, the fact that it required two discharges and two charges after a long rest before the discharge curve (the third after the rest) acquired its normal form, tends to show that this rise of P.D. at the commencement of the first discharge after a long rest is due to some other cause.

Again, Prof. Duncan and Mr. H. Wiegand have shown in their communication that the diffusivity of the sulphuric acid into the plugs is greatest at the end of the charge, and least at the end of the discharge. Hence, if it be the diffusing out of the strong sulphuric acid from the plugs of the positive plate that causes the rapid fall of E.M.F. on breaking the charging circuit at the end of a charge (see figs. 3, 4, and 11), one would hardly expect that it would be at the end of the discharge, when the diffusivity of the acid in the plugs was a minimum, that the rise of E.M.F. on breaking the discharging circuit would be most rapid, but that numerous experiments have shown us to be the case. In fact, curve No. 8, fig. 11, shows that towards the end of the charge the E.M.F. falls from 2.298 to 2.274 volts in 20 seconds after breaking the charging circuit, and similar curves that we have drawn from our experiments on the time rise of E.M.F. on breaking the discharging circuit show that towards the end of the discharge the E.M.F. rises from 1.951 to 1.970 volts in 20 seconds, the latter rate of rise being almost exactly equal to the former rate of fall.

All the rests already referred to occurred when the cells were fully charged; but before these long rests took place the cells, when in their normal state, were on one occasion allowed to remain discharged for 34 minutes, with the following result:—

#### Cells in Normal State.

##### Time taken to complete—

Discharging	10 h. 10 m.	Charging	11 h. 38 m.
Next	„ 10 h. 12 m.	Next	„ 11 h. 37 m.
Next	„ 10 h. 11 m.	Next	„ 11 h. 37 m.
Cells here remained discharged for 34 minutes.			
First discharging after rest,	10 h. 15 m.	First charging after rest,	11 h. 50 m.
		Next charging after rest,	11 h. 42 m.

These results emphasise the fact that accumulators are damaged if left discharged even for a short time, and it was for this reason that during the whole of this investigation the cells were never left discharged for a longer time than was necessary to change over the connections from discharge to charge, except on this one occasion when it was desired to ascertain the magnitude of the change produced by leaving the cells discharged for a short time.

It is interesting to notice that the effect of discharging cells too low, or of leaving them discharged, is to increase the times required for the subsequent chargings, whereas the effect of leaving them charged is to diminish the times required for the next chargings.

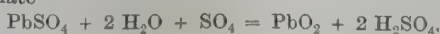
#### VIII.—CHEMICAL ACTION.

Dr. Frankland has shown that probably the discharge of an ordinary accumulator is accompanied by the formation of one or other, or both, of the new lead salts which he has isolated, and which have the formulæ  $(\text{Pb}_2\text{S}_2\text{O}_{10})$  and  $(\text{Pb}_3\text{S}_3\text{O}_{14})$  respectively. And he concludes that, in view of the great difficulty of electrolytically splitting up the well-known white sulphate of lead  $(\text{PbSO}_4)$ , this sulphate is not formed in the ordinary discharge of the accumulator, and is only produced when the cell begins “to sulphate.”

Prof. W. Kohlrausch and C. Heim show in their paper already referred to that the observed variations in the specific gravity of the liquid during charge and discharge agree well with the very simple chemical actions—

##### Charge.

Positive plate—



Negative plate—

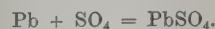


##### Discharge.

Positive plate—



Negative plate—



It is to be noticed, however, that the falling off in the specific gravity during discharge is merely a test of the amount of  $\text{H}_2\text{SO}_4$  that is converted into  $\text{H}_2\text{O}$ , and affords no criterion as to what sulphate of lead is formed by the  $\text{SO}_3$  liberated.

During our investigation we observed the variation in the specific gravity of the liquid during about 100 charges and discharges, and the mean of this large number of the fairly consistent results that we obtained showed that, with the accumulators we were testing, the variation in density per ampere-hour was about 0.000232. This result is probably right to within 5 per cent., for our hydrometer would read accurately to about 0.001, which is about 5 per cent. of 0.03, the total change in specific gravity observed during the discharge; and, therefore, as each result is correct to something like 5 per cent., the mean of a hundred results will certainly be correct to within 5 per cent.

On referring to tables of the density of dilute sulphuric acid, we find, by plotting the results, that between the limits we are concerned with—1.2 and 1.17—the change of density is directly proportional to the amount of  $\text{SO}_3$  taken from the solution; and, further, that to produce a change in density of 0.01 at 15° C., it requires that 1 gramme of dilute sulphuric acid of density 1.2 should give up 0.01268 of a gramme of  $\text{SO}_3$ . And as the liquid in each cell weighed about 10,490 grammes when the cell was charged and the density 1.2, it follows that the weight of  $\text{SO}_3$  liberated per ampere-hour in each cell, when calculated from the variation in the specific gravity, must equal—

$$\frac{0.000232}{0.01} \times 0.01268 \times 10,490 \text{ grammes,}$$

or

$$3.086 \text{ grammes.}$$

Further, the electro-chemical equivalent of  $\text{SO}_3$  is 0.000414 grammes per coulomb; and since lead sulphate is formed on both the positive and negative plates during the discharge, the weight of  $\text{SO}_3$  taken out of the liquid per ampere-hour, when calculated from the electro-chemical equivalent of  $\text{SO}_3$ , must be

$$2 \times 3,600 \times 0.000414 = 3.041 \text{ grammes.}$$

These two results show a close agreement. At the same time, it is to be noticed that not merely does the amount of  $\text{SO}_3$  liberated per ampere-hour come out somewhat higher when calculated from the mean change in the specific gravity than when calculated from the chemical equivalent, but the same result is obtained for each separate set of tests.

Mr. G. H. Robertson, working in Dr. Armstrong's laboratory, was so good as to analyse the sediment that fell to the bottom of the cells during the early part of the investigation, when in the discharges the P.D. was allowed to fall to 1.6 volts per cell. The mixture was found to contain—

An indication of uncombined metallic lead,

A trace of antimony,

40.95 per cent. of combined lead	} i.e., 47.3 per cent. of $\text{PbO}_2$
6.35 „ „ oxygen	
34.63 „ „ lead	
5.36 „ „ sulphur	
10.75 „ „ oxygen	} i.e., 50.74 „ „ $\text{PbSO}_4$
	98.04

so that 1.96 per cent. consisted of metallic lead, antimony, and dirt.

The composition of the sediment showed a close approximation to  $\text{PbO}_2$ ,  $\text{PbSO}_4$ , which consists of—

44.08 per cent. of $\text{PbO}_2$
55.92 „ „ $\text{PbSO}_4$

$\text{PbO}_2$ ,  $\text{PbSO}_4$ , in fact, contains—

76.33 per cent. of Pb
5.91 „ „ S
17.76 „ „ O

and the sediment contained—

75.58 per cent. of Pb
5.37 „ „ S
18.05 „ „ O

Dr. Frankland's salts may be represented as  $\text{PbO}_3$ ,  $2(\text{PbSO}_4)$  and  $2(\text{PbO})$ ,  $3(\text{PbSO}_4)$  respectively, whereas the analysis of the deposit in our cells showed that it was certainly neither of these lead salts, but, instead, had almost the exact composition of  $\text{PbO}_2$ ,  $\text{PbSO}_4$ .

In spite of accumulators with pasted plates having been in use now for nine years, the chemical action that takes place during the different stages of the charge and discharge has only been conjectured, and, odd as it seems, no decisive experiment appears to have been made to settle this much debated question. Various analysis have been made by different chemists of salts of lead acted on in certain ways with sulphuric acid, but apparently not of actual accumulator plates in action. We are therefore now, with the assistance of Mr. Robertson, making a complete investigation of the chemical state of the plugs of both the positive and negative plates at all stages of the charge and discharge of an 1888 E.P.S. type of accumulator in good condition. As this investigation, however, involves the chemical analysis of

a large number of specimens, it will take some time yet to complete.

In order to observe what changes took place in the temperature of the cells during charge and discharge, the temperature of one of the cells under test was observed from time to time, as well as the temperature of the air and the temperature of an adjacent cell through which no current was being passed. The following temperature results, which were obtained during the steady discharges and charges after the first rest of ten days (curves 10 and 11), are a sample of the observations taken. The discharge in each case commenced directly the P.D., in charging, had reached 2·4 volts per cell, and the charge in each case commenced directly the P.D., in discharging, had fallen to 1·8 volts per cell.

H. Wiegand in America, and described in their joint investigation already referred to.

From the last table we see that the rise of temperature of the cell during charging may, after allowing for changes of temperature of the room, be either about 1·3° C. or 0·77° C., while the fall of temperature during discharging may have either of the two preceding values. It is further interesting to notice that the rise of temperature during the charging has the higher or the lower of these two values, according as the fall of temperature during the previous discharge had the higher or the lower value.

On plotting the differences between the temperatures of the working and the idle cell, and the corresponding times given in the last table, we obtain the dotted line, 24 (fig. 8), for the time fall of temperature during the first and third discharge, curve 25

Date.	Time.	Cell under test.			Temperature of			Time from beginning of discharge or charge.	Difference between temperature of cell under test and temperature of idle cell.	Rise or fall of temperature during a complete discharge or charge, compared with temperature of idle cell.		
		State.			Temp.	Air.	Idle cell.					
	Hrs. min.				Degrees C.	Degrees C.	Degrees C.	Hrs. min.	Degrees C.			
1889. July 10th ...	1 10	Charged	...	...	19·95	18·75	18·6	0 0	1·35	}	- 1·25 during discharge.	
" ...	11 20	Discharged	...	...	18·6	18·6	18·5	10 10	0·1			
" ...	16 55	Charging	...	...	19·6	19·1	18·84	5 35	0·76	}	+ 1·2 " charge.	
" ...	21 6	"	...	...	19·9	19·0	18·9	9 46	1·0			
" ...	22 50	Charged	...	...	20·2	18·8	18·9	11 30	1·3	}	- 0·70 " discharge.	
July 11th ...	7 55	Discharging	...	...	18·65	18·25	18·1	9 5	0·55			
" ...	8 50	Discharged	...	...	18·8	18·5	18·2	10 0	0·6			
" ...	11 38	Charging	...	...	19·05	18·6	18·4	2 48	0·65	}	}	+ 0·77 " charge.
" ...	15 10	"	...	...	19·3	18·8	18·5	6 20	0·8			
" ...	19 50	"	...	...	19·7	19·0	18·7	11 0	1·0	}		
" ...	20 25	Charged	...	...	20·1	19·0	18·73	11 35	1·37			
" ...	21 42	Discharging	...	...	19·95	18·95	18·85	1 22	1·10	}	}	- 1·40 " discharge.
July 12th ...	5 40	"	...	...	18·72	18·75	18·75	9 20	- 0·03			
" ...	6 20	Discharged	...	...	18·72	18·75	18·75	9 55	- 0·03	}	}	+ 1·33 " charge.
" ...	7 50	Charging	...	...	19·3	18·65	18·7	1 30	0·6			
" ...	10 30	"	...	...	19·5	19·0	18·78	4 10	0·72	}		
" ...	12 40	"	...	...	19·61	19·1	18·77	6 20	0·84			
" ...	17 45	Charged	...	...	20·40	19·26	19·1	11 25	1·30	}		
" ...	21 30	Discharging	...	...	19·95	19·25	19·1	3 45	0·85			
July 13th ...	0 22	"	...	...	19·7	19·1	19·1	6 37	0·6	}	}	- 0·67 " discharge.
" ...	2 55	"	...	...	19·73	19·2	19·16	9 10	0·57			
" ...	3 52	Discharged	...	...	...	...	...	10 7	...	}		
" ...	3 58	Just started charging	...	...	19·78	19·08	19·15	0 8	0·63			
" ...	10 20	Charging	...	...	20·0	19·2	19·15	6 28	0·85	}	}	+ 0·77 " charge.
" ...	12 0	"	...	...	20·05	19·2	19·15	8 8	0·90			
" ...	14 20	"	...	...	20·30	19·25	19·2	10 28	1·1	}		
" ...	15 30	Charged	...	...	20·6	19·4	19·2	11 38	1·4			

Variation of temperature during discharge and charge.

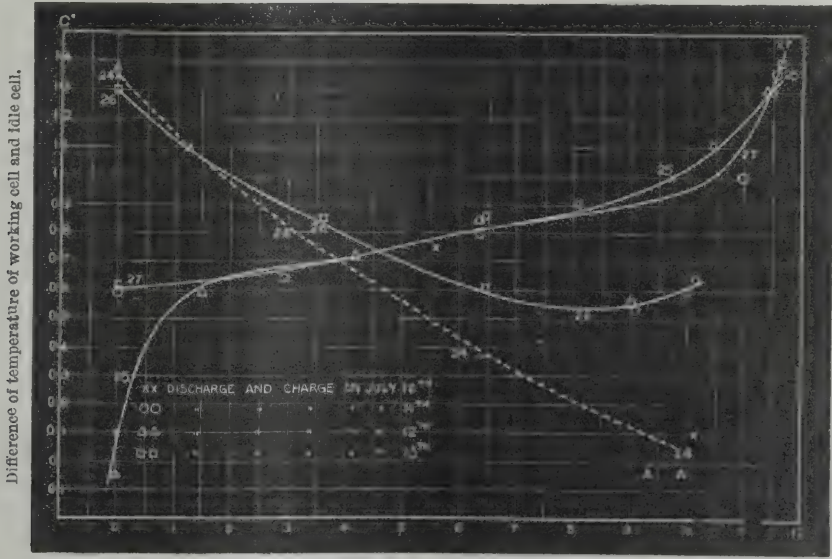


FIG. 8.

From the preceding table we see that, while during the charge the cell rises in temperature, during discharge, on the contrary, it actually falls; hence, in spite of the production of heat due to resistance, the cell is actually cooler at the end of a discharge than at the beginning—a result possibly due to the splitting up of the sulphuric acid during the discharge. This cooling of accumulators during discharge, which we noticed early in our experiments, was also observed at about the same time by Prof. Duncan and

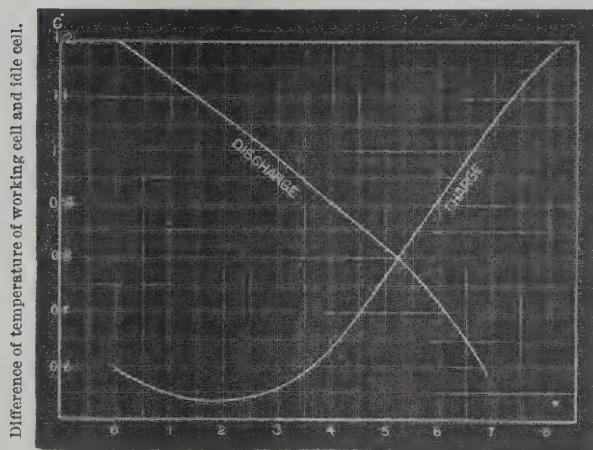
for the time rise of temperature during the first and third charge, curve 26 for the time fall of temperature during the second and fourth discharge, and curve 27 for the time rise of temperature during the second and fourth charges. 24 is dotted, since temperature readings were only taken at the beginning and end of the first and third of these discharges. In the case of the second and fourth of the discharges here referred to, as well as in all the four charges, several observations of temperature were made.

From the curves it appears that towards the end of the discharge and at the beginning of the charge, one or other of two things may happen—either the temperature in the discharge may go on falling, as in the dotted line, 24, or it may begin to rise again, as in 26; whereas, in the charge, either the temperature at the beginning may rise considerably, as in curve 25, or it may only increase slightly, as in curve 27.

It would therefore appear that during the latter part of the discharge one or other of two chemical actions can take place; and these two actions have, for some reason or other, taken place alternately in the four discharges under consideration. But, curiously enough, these four discharges—which took place on July 10th, 11th, and 12th, 1889—occurred with extreme regularity; so that when the time curves were drawn, even on a large scale, for each of these discharges, they coincided exactly and produced a single curve, which is shown, greatly reduced, as curve 10 on the sheet of curves given in the earlier part of the paper. And, similarly, for the four corresponding charges the four time curves all coincided exactly, producing a single curve, which is shown, greatly reduced, as curve 11 on the same sheet. It, therefore, seems as if one or other of two chemical actions might take place during the latter portion of the discharge and during the earlier part of the charge, and yet, curiously enough, when the current is kept absolutely constant the time variation of the P.D. is exactly the same, no matter which of these two chemical actions takes place.

About a year later another set of continuous temperature observations was made for many days and nights with the same cells, the current in discharging and charging being, as before, 10 and 9 amperes respectively. The higher P.D. limit was, as before, 2.4 volts per cell, but the discharge was in each case in this second set of continuous discharges and charges, stopped at 1.9 instead of 1.8 volts per cells. As the regulation of the current day and night was in these later experiments in 1890 effected by hand, it was not kept quite as constant as when the automatic regulator was

Variation of temperature during discharge and charge.



Time in hours from beginning of discharge or charge.

FIG. 9.

employed. Hence the time curves for the excess temperature in discharging and charging, when plotted, were not found to be as regular as in the previous case. But they were quite regular enough to give the general shape of the sets of temperature curves for discharge and charge which are shown in fig. 9.

It will be observed that in these experiments not merely does the excess of the temperature of the working cell over that of the idle cell fall during the discharge, but it actually continues to fall at the commencement of the charge.

The times of discharging and charging are less than those given for curves 10 and 11, partly because the P.D. was not allowed to run down lower than 1.9 volts per cell in the later observations, and partly because the times of discharging and charging had been diminished by the continued experimental rests to which these cells had been subjected in a charged state during 1889.

The mean temperature of one of our cells is during charging and discharging, roughly,  $0.7^{\circ}\text{C}$ . higher than that of the air; and experiment shows that if one of the cells experimented on be warmed up by a portion of the ordinary dilute sulphuric acid being replaced by warm sulphuric acid of the normal density, the cell will, after all parts of it have acquired a uniform temperature, fall in temperature by  $0.2443^{\circ}\text{C}$ . per hour. Of course, during such an experiment no current is allowed to pass through the cell, nor should any current have passed for hours before the heat emissivity of a cell is determined, otherwise a wrong value of the emissivity may be obtained by local action in the cell generating or absorbing heat during the experiment.

Hence, if  $\kappa$  be the heat capacity of the cell,  $0.7 \times 0.2443 \times \kappa \times 21\frac{1}{2}$  calories (gramme, centigrade) will be lost by radiation and convection during the  $21\frac{1}{2}$  hours of charging and discharging. Now the weights and specific heats of the component parts of one of the cells under test are:—

	Weight in Grammes.	Specific Heat.
Dilute acid, sp. gr. 1.9	10,490	0.792
Lead and lead oxide...	12,987	0.0315
Glass	3,402	0.198

Hence,  $0.2443 \kappa$  equals 2,295 calories, and the loss of heat in charging and discharging equals 34,520 calories. The total watt-hours given to a cell in charging was 228.2 (see curve 11 for the working results obtained with the cells after the first rest of 10 days), therefore the energy in calories given to the cell was  $0.24 \times 228.2 \times 3,600$ , or 197,200 calories. Hence, in consequence of the cell being slightly warmer than the air during charging and discharging, there is a loss of energy from radiation and convection equal to about 17 per cent. of the energy put into the cell, and this is more than sufficient to explain the total loss observed in the energy efficiency experiments, which amounts to only about 13 per cent. Indeed, it would almost seem as if a portion of this heat radiated must be supplied by an actual slow consumption of the material of the cell; so that, in addition to the reversible oxidation and deoxidation of the material, which is the characteristic of the secondary cell, there was a certain amount of non-reversible oxidation, which is the characteristic of the primary cell.

The loss of energy in consequence of the current having to overcome the resistance of the cell is of far less importance than the loss of energy due to the actual continuous radiation and convection from the cell, which is slightly warmer than the air. For the mean resistance during discharging of one of the cells experimented on may be taken as  $0.004$  ohm (see Section IX., Resistance, figs. 12 and 13), and the mean resistance in charging as  $0.0045$  ohm. Hence, during the normal 10 hours of discharge with 10 amperes there will be generated,

$$0.24 \times 10^2 \times 0.004 \times 10 \times 3,600, \text{ or } 3,456 \text{ calories,}$$

and during the normal  $11\frac{1}{2}$  hours of charge with 9 amperes,

$$0.24 \times 9^2 \times 0.0045 \times 11\frac{1}{2} \times 3,600, \text{ or } 3,621 \text{ calories.}$$

Only, therefore, 3,456 calories need be dissipated during the discharge of a cell, and 3,621 during the charge, in consequence of the heat produced by the current overcoming resistance; and to dissipate this amount of heat it would only be necessary that the mean temperature of the cell should exceed that of the air by about  $0.14^{\circ}\text{C}$ ., or only about one-fifth of the actual mean excess. Whereas what actually takes place is that during discharge about 16,060 calories are dissipated by radiation and convection; and, further, the cell cools down, possibly in consequence of the splitting up of the sulphuric acid, and from 6,000 calories in some experiments to 12,000 in others are thus absorbed. During the charge these 6,000 or 12,000 calories reappear warming up the cell, and, in addition, about 18,460 calories are dissipated by radiation and convection.

In order, then, to improve accumulators, what has to be especially sought for, and, if possible, then prevented, is that chemical action which keeps the mean temperature of the cell about  $0.7^{\circ}\text{C}$ . above that of the air. This chemical action is very possibly quite distinct from the reversible one which necessarily accompanies the storing up of the electric energy and its subsequent liberation.

#### IX.—RESISTANCE.

The resistance in ohms of an accumulator when charging and discharging is given respectively by

$$\frac{V - E}{A}, \text{ and } \frac{E - v}{A},$$

where  $v$  is the P.D. in volts at the terminals when a current of  $A$  amperes is passing, and  $E$  is the E.M.F. of the accumulator at the moment  $v$  is measured. To measure  $E$  the main circuit is broken, and the P.D. observed as quickly as possible. On breaking the circuit, however, the deflection of the voltmeter does not sharply change from the value that measured  $v$  to another definite value that measures  $E$ ; but, on the contrary, as seen from fig. 4, in consequence of the fall of the E.M.F. of an accumulator on breaking the charging circuit, and in consequence of a similar rise in the E.M.F. on breaking the discharging circuit, the voltmeter deflection continues to vary for several minutes after the circuit is broken. Hence the value of  $E$ , measured by a voltmeter which is not infinitely dead-beat, must be too small during charging, and too large during discharging; and consequently, since the above formulæ for the resistance are only true when  $v$  and  $E$  are the simultaneous values of the P.D. at the terminals of the accumulator and of its E.M.F., it follows that the resistance has hitherto been measured too large both in charging and discharging.

The magnitude of the error that has been thus made in different experiments depends, of course, on how dead-beat a voltmeter was employed, and, consequently, on how long a time was allowed to elapse between the breaking of the main circuit and the taking of the reading. For example, we find that towards the end of the charge with the normal current of 9 amperes the E.M.F. varies about 1 per cent. in 20 seconds after the circuit is opened. Now, as the difference between  $v$  and  $E$ , which measures the resistance, is only of the order  $0.1$  volt when it has its maximum value during the normal charge or discharge—that is, of the order 4 per cent. of  $E$ —it follows that an error of 1 per cent. in the measurement of  $E$  would make an error of about 25 per cent. in the measurement of the resistance.

To measure the resistance accurately, we ought to be able to measure the difference between  $v$  and  $E$  to one-thousandth of a volt, and, therefore, as  $E$  is about 2 volts, the voltmeter must be very sensitive, with a long, open scale, and the needle must move through a considerable angle; whereas, in consequence of the rapid variation in  $E$ , the voltmeter must be very dead-beat—a condition almost incompatible with a long range and great sensibility.

(To be continued.)

THE TELEPHONE IN SWEDEN AND  
NORWAY.

In February of this year a report on the telephone and its extension at Stockholm and Gothenberg was presented to Parliament, and now another, referring to the telephone system at Christiania, has been printed. From this report we learn that the International Bell Company was the first, in 1880, to establish telephonic communication at Christiania. In 1881 a "Telephone Association" entered into competition with it, and obtained by the end of that year 224 subscribers, against 462 subscribers to the Bell Telephone Company. The two telephone systems continued to operate in competition with each other until the end of December, 1885, when the Bell Company had already fixed 995 apparatus, and the Telephone Association 634, representing an aggregate total of 1,629 subscribers. Their amalgamation into one company was at last effected by pressure on the part of the municipality, which prohibited the Bell Company and the Association from putting up any more wires separately.

On the 1st January, 1886, the Christiania Telephone Company superseded the two original companies, which were indemnified on the following terms, namely:—

Bell Company (its property was valued at £8,333) ... ..	£13,384
Telephone Association (valuation of property, £4,444) ... ..	7,000
Total ... ..	£20,384

The capital of the Christiania Telephone Company is 500,000 kroner (about £27,890), raised on 2,500 shares of 200 kroner (£11 2s. 3d.) each. The dividend declared for 1889 amounted to 5 per cent. on that capital, and the shares now stand at 25 per cent. premium. The number of subscribers on the 1st January, 1890, was 2,133, and their increase, expressed as a percentage, has been as follows:—

	Per cent.
1886 ... ..	7
1887 ... ..	17½
1888 ... ..	33
1889 ... ..	53½

The total number of apparatus under the control of the company at the end of 1889 was 2,405, of which 68 belonged to subscribers.

The following are the regulations under which telephones are established and worked in Norway:—

By a Royal decree issued in 1884, a law of July 31st, 1859, regulating the construction and maintenance of railways and telegraph lines in Norway was made applicable to the establishment of telephonic communication. In virtue of that decree permission has been granted to companies to establish telephonic communication either between towns and surrounding districts, or in rural districts between such districts, or with neighbouring towns, the licenses remaining severally in force for a period of five years. No exclusive right is given to individual companies, but no licenses are granted to competing companies before all the local authorities have been consulted. A royalty is payable under a license only when the telephonic communication has been established between two or more places where telegraph stations are maintained by the State. The royalty annually payable is then calculated on a scale proportionate to the receipts from telegraphic correspondence between the points in question, and is generally fixed at one-half or one-third of such revenue. The licenses contain no conditions as to the purchase of the telephone exchange systems by the State, either within the periods for which they have been granted or on the expiration of non-prolongation of a license. The State allows telephone companies to place exchanges in connection with telegraph offices at their own cost, and without any responsibility on the part of the telegraph service for secrecy or accuracy of transmission. No charge is made to companies for such connection. A few companies have erected on their lines public telephone stations, to which telegrams can be sent from any telegraph office in the country. The companies are allowed to charge for the transmission of the telegrams sent by their lines a general rate of 0.50 kroner (6½d.), regardless of the number of words. The tariff books of the State telegraphs specify this rate, and give the names of the telephone stations.

An exception, however, from this arrangement has been made in regard to the connection of a couple of places, where there had previously been State telegraph offices, with a private telephone in a neighbouring town. In these cases the State has given a subvention once for all, on condition that call offices should be provided, no extra charge made for telegrams, and a moderate tariff fixed for other use of the telephone from the points in question to the central office. The telephones established in certain rural districts by the State are regarded as part of the telegraph system, and are to some extent worked on telegraph lines that are utilised by the telegraph during only part of the year. In such places contracts are made for certain short periods of years with the interested parties, under a communal guarantee to the effect that an efficient clerk not connected with any mercantile business will be kept at the cost of such parties, and that the contractors will undertake the entire working of the telephone station, including free accommodation, lighting, heating, and the services of a messenger. They are granted a small subvention not exceeding 200 kroner (£11 2s. 3d.) per annum, and a small return of the

charge for each conversation through the telephone is made to them. Telegrams are in such cases free of extra charges. In a couple of valleys, through the State telegraph lines run, telephone wires have been erected on the telegraph poles in order to connect road posting stations with the nearest telegraph office. These offices are all established on the principle just mentioned, except that the contracts remain in force for 10 years, and the contractors receive no subvention from the State, which has defrayed the cost of the lines and erection of the telephone stations, and which undertakes the repair of the lines and the keeping of the apparatus in order.

With regard to the description of telephone generally used, the gentleman sending the report to the Foreign Office (Mr. T. Mitchell) says it is the ordinary apparatus with magneto-electrical call bells. Relatively few apparatus of the electro-magnetic type, with which signals are given by battery current, are in use. The transmitters are generally on Blake's, and only a few on Ader's system. The receiver is either a Bell (one pole), or a Siemens (two pole) telephone. At the exchanges in Christiania and Bergen the central apparatus consist of multiple switchboards, but at all other places of switchboards of older construction. The apparatus are partly patented, and the State has no right to use or make them. The cost of a complete telephone, comprising one transmitter and one receiver, ranges, according to decorative finish, between 72 kroner (£4) for a magneto-electrical apparatus from the *Elektrisk Bureau* at Christiania, or from Ericsson at Stockholm, and 56 kroner (£3 2s. 3d.) for Bell Blake's apparatus, from the Bell Telephone Manufacturing Company at Antwerp. The average cost of maintaining in working order a complete telephone (transmitter, receiver and battery, or magneto-electrical call bells) is reckoned to be from 15 to 20 kroner (16s. 8d. to 22s. 3d.) per annum. The wires used for the State telephone lines are all of silicium bronze, of a gauge 2 mm. in diameter. Except at Christiania and Bergen, where silicium bronze wire 1.25 mm. in diameter is partly applied, the private companies use for the exchanges Swedish iron wire of 22 mm. in diameter. At Christiania aerial cables, containing 27 or 52 wires, are used in the vicinity of the central station. For inter-urban lines iron wire 3 mm. in diameter is used on short distances, and silicium bronze from 1.5 to 2.5 mm. in diameter on longer ones. The average cost per annum to the companies of maintaining 1 kilom. of wires is calculated to be from 10 kroner to 15 kroner (11s. 1½d. to 16s. 8d.). Private inter-urban wires are not allowed to be erected on the State telegraph poles. The State telephone wires are erected on the telegraph poles on the English system, which has been effective in preventing induction. The average cost of poles varies according to the place where the construction of lines takes place. The State pays for the best poles, 25 feet long, 6 inches in diameter at the top, with 3 to 4 inches heart, on an average 30 kroner (33s. 4d.) per dozen. The prices of poles supplied to the Christiania Telephone Company are as follows:—For pine 25 feet in length, 20 kroner (22s. 3d.); for fir, 22 kroner (24s. 6d.) per dozen; for pine, 50 feet in length, 70 kroner (77s. 9d.); for fir, 85 kroner (54s. 6d.) per dozen. The cost of wire is the ordinary market price. Silicium bronze wire, more especially, has been very fluctuating of late in price. The porcelain insulators for the State telephone lines (the type being the same as that used for telegraph lines) cost about 0.50 kroner (6½d.) a piece. The cost of the double insulators used by the private companies is about 0.17 kroner (2d.). The cost of labour in the erection of the State telephone lines is the same as that for telegraph lines, and varies greatly according to the more or less mountainous ground to be passed. The average cost is about 80 kroner (88s. 11d.) per kilom. The private companies estimate the cost of labour at about 30 kroner (33s. 4d.) along the roads. On the houses it varies very much. The average may be said to be 25 kroner (27s. 9d.). It may here be remarked that the exchange and office work of the Christiania Telephone Company is principally performed by females. The annual charge for the use of a telephone in connection with an exchange varies greatly in the different companies: in the mutual societies, where the subscribers are owners of the lines, the apparatus, and the central station, the charge is from 30 kroner (33s. 4d.) to 60 kroner (66s. 8d.) per annum. When the companies are founded on shares, the annual charge is within the first circle (generally 1½ kiloms. from the central station) from 50 kroner (55s. 7d.) to 100 kroner (111s. 2d.), and is increased for greater distances. The Christiania Telephone Company, founded on shares, make an annual charge for the 1st circle of 80 kroner (£4 8s. 11d.), with an addition of 7.50 kroner (8s. 4d.) for each half kilom. beyond. The subscribers of telephone companies founded on shares are generally bound for one year. The mutual societies have not bound themselves to give any compensation for lines and apparatus belonging to former members. On the State telephone lines there is no special charge made for the telephoning of telegrams. For conversations by telephone the charge is 0.20 kroner (2½d.) to 0.50 kroner (6½d.) for five minutes. Public call offices are provided only in a few towns. At Christiania they are generally established in the house of a subscriber (generally a shop), who receives a remuneration of 30 per cent. of the revenue, the charge for each conversation being 0.10 kroner (1½d.), whether to subscribers or non-subscribers. All the telephone exchange wires are aerial and single. The existing trunk wires between towns (communications inter-urbaines) are all maintained by the companies, namely, between the following places:—Christiania-Gjøvik, annual royalty to the State 300 kroner (£16 13s. 4d.), distance about 110 kilom., charge for five minutes' conversation 0.50 kroner (6½d.). Christiania-Hønefos, distance about 60 kilom., charge for five minutes' conversation 0.50 (6½d.). Drammen-Kongsberg. Chris-

tiania-Moss, annual royalty to the State 2,000 kroner (£111 2s. 3d.), distance about 60 kilom., charge for five minutes' conversation 0.50 kroner (63d.) Skien-Porsgrund, royalty to the State 500 kroner (£27 15s. 7d.). Porsgrund-Langesund, royalty to the State 200 kroner (£11 2s. 3d.) The State has the right to erect poles and wires on public roads and private property against full compensation for value and damage under the provisions of the law of July 31st, 1859. Companies have no such legal right, but the local authorities and the landowners generally give permission to that effect without making any charge, the establishment of a telephone exchange being in the interest of the local inhabitants. The State telephone lines are regarded financially as part of the telegraph system, and the expense of their maintenance is expected to be covered by the revenue they yield. The total number of telephone exchanges (all private) in Norway is 30. The number of subscribers to each exchange, and the total number of inhabitants in each town or locality are shown in a statement hereunto annexed. The Government does not interfere in the establishment of private telephone systems to a greater extent than may be necessary in order to avoid collision between the different companies, and in order to protect the interests of the State telegraphs. In the latter respect the State only requires remuneration for a decrease in the number of telegrams exchanged between telegraph offices, contingent on the establishment of telephone lines between the same places. The system on which telephones are established and worked in Norway seems to be well adapted to a country of which the population is spread over a large extent of territory. The telephone exchange systems have, more especially in the two or three last years, grown rapidly—first, within the limits of certain towns or parishes, and then expanding to the surrounding districts or parishes. The telephone is being more and more regarded as a convenience of household necessity. What bells are for calls inside a house, the telephone is for outside calls; and as there is no charge for royalties, &c., included in the cost of establishing an exchange, the subscription rate can be made so low that the acquisition of a telephone apparatus is within the reach of moderate means.

There are three appendices to the report, the third of which is as follows:—

The Number of Subscribers to each Telephone Exchange in Norway is:—

	Subscribers.	Inhabitants.
Christiania ... ..	2,133	140,000
Bygdø ... ..	35	Rural districts. The Christiania Telephone Company.
Strømsborg ... ..	7	
Sandviken ... ..	11	
Lillestrømmen ... ..	16	
Malmöen ... ..	9	
Dröbak ... ..	13	2,000
Hønefos ... ..	13	1,400
Bergen ... ..	750	50,000
Trondhjem ... ..	315	25,000
Drammen ... ..	145	20,000
Stavanger ... ..	148	24,000
Fredrikstad ... ..	142	12,000
Fredrikshald ... ..	97	11,000
Laurvik ... ..	90	11,000
Skien ... ..	94	7,000
Moss ... ..	70	7,000
Tromsø ... ..	63	6,000
Tønsberg ... ..	62	7,000
Christianssund ... ..	51	10,000
Christianssand ... ..	50	13,000
Arendal ... ..	50	4,000
Porsgrund ... ..	37	4,500
Langesund ... ..	?	Lately established.
Aalesund ... ..	37	7,000
Kragerø ... ..	28	5,000
Hammerfest ... ..	21	1,500
Sarpsborg ... ..	37	2,800
Haugesund ... ..	?	P Lately established.
Hamar ... ..	?	P " "
Horten ... ..	70	" 6,000 "
Bodø ... ..	?	P Lately established.
Kongsvinger... ..	57	P
Elverum ... ..	57	P Rural districts.
Slokmarknes-Mebbo	7	...
Vormsund ... ..	23	Rural districts. The Nøes Telephone Company.
Ingeborrud ... ..	3	
Trøgstad ... ..	11	
Nannestad... ..	5	Rural districts. The Oplandenes Tele- phone Company.
Eidsvold ... ..	27	
Vestre Toten Gran... ..	} Lately esta- blished {	
Ostre Toten Gjøvik		

NEW PATENTS—1890.

10939. "Electric lamp holder and switch for capped incandescent lamps." C. McDONALD. Dated July 14.

10941. "Improvements in electrical contacts or collectors of electricity for railways and other purposes." F. WYNNE. Dated July 14.
11017. "Improvements in or relating to conduits and permanent way for electric railways." W. P. THOMPSON. (Communicated by J. Lynch, United States.) Dated July 15. (Complete.)
11042. "Improvements in electric thermometers and thermographs." J. W. GOOCH, C. A. BAKER and W. WHITE. Dated July 15.
11045. "Improvements in printing telegraphs." W.W. TAYLOR and E. M. LEAVENS. Dated July 15. (Complete.)
11052. "Improvements in telegraph receivers." C. LANGDON-DAVIES. Dated July 15.
11061. "Improvement in electric railway switches." H. H. LAKE. (Communicated by W. D. Swart, United States.) Dated July 15.
11065. "Improvements relating to the impregnation of organic, fibrous, and cellular matter, by means of an electric current, and apparatus therefor." G. A. ONCKEN. Dated July 15.
11070. "Improvements in and connected with electric measuring instruments, incandescent lamps, telephone transformers, electrically worked organs, and materials for jellygraph copying and printers' rollers." J. SWINBURNE. Dated July 16.
11130. "Improvements in insulating compositions for electrical purposes." A. N. FORD. Dated July 17.
11187. "Improvements relating to the manufacture of articles by electro-deposition, and to compositions for use in such manufacture." A. W. ARMSTRONG. Dated July 17.
11193. "Improvements in electrical switches." J. TRECZIOK. Dated July 17.
11240. "Improvements in electric arc lamps." J. Y. JOHNSON. (Communicated by L. Bardon, France.) Dated July 18. (Complete.)
11263. "Improvements in wall sockets for temporary electric connections." J. M. M. MUNRO. Dated July 19.
11272. "An improved ceiling rose for the suspension of electrical fittings." T. R. ANDREWS and T. PREECE. Dated July 19.
11312. "An improved device for maintaining electrical connection between separate railway trains." J. P. BAYLY. (Communicated by A. Baker, United States.) Dated July 19.
11319. "Improvements in apparatus to be used for electric welding." H. HOWARD. Dated July 19.
11327. "Improved electrically operated stamping and crushing machines." C. T. J. VAUTIN. Dated July 19.

ABSTRACTS  
OF PUBLISHED SPECIFICATIONS, 1889.

4125. "Improvements in holders for incandescence electric lamps." W. O. ROOPER. Dated March 8. 8d. The holder consists of a cylindrical body made of vulcanite fibre, ebonite, china, or other suitable non-conducting material, to the outer surface of which are attached two or more spring clips which embrace the neck of the lamp bulb or globe, and two metallic attachments fitted with binding screws for connecting the leads to the lamp wires. The upper external part of the body of the holder is screw threaded to receive a screwed cap of brass or other suitable material, having a hole in the centre of the top thereof, through which the leads or conducting wires are passed on their way to the aforesaid metallic attachments. 5 claims.
5976. "An improved automatic electric alarm clock." A. LEYLAND. Dated April 8. 8d. Has for its object that of providing an electric alarm that will ring until stopped, and re-set itself ready for being operated, according to the time intended by the alarm dial. 4 claims.
6384. "Improvements in and relating to electric switches." A. A. GOLDSTON. Dated April 13. 8d. Claims:—1. In an electrical switch, the combination of a switch lever provided with two conducting pieces insulated from each other and adapted to be permanently connected to the main circuit, and two pairs of contacts, one of which pairs is designed to be connected with the terminals of the circuit to be introduced, while the other pair is in electrical connection, all arranged and operating substantially as described. 2. An electrical switch adapted to cause the main line current to pass through an "introduced" circuit or through a short circuit, the arrangement being such that when the current is passing through the short circuit the terminals of the "introduced" circuit will be out of electrical contact with the switch or with themselves, substantially as described. 3. The manufacture and use of the improved electrical switch described and illustrated in the drawing.
8157. "Improvements in switches for electric signalling apparatus." L. SELLNER. Dated May 16. 8d. Relates to switches by means of which any desired lamp from a number of white and coloured or continuously and intermittently lighting electric incandescent lamps can be interposed into the circuit of an electric current generator, in order to give a signal, while, at the same time, an equal number of other lamps, provided for maintaining in the circuit unvariable resistance, are put out of circuit. 6 claims.

18638. "Improvements in the mode of driving electrical vehicles." A. DICKINSON. Dated November 21. 6d. The gear is all mounted in an extra frame, one end of which is pivoted upon one of the bogie axles, and the other end is so mounted in a radial axle box or horn plates that this end of the frame is free to move upwards and downwards, but its liberty is governed by spring arranged to check its movement within certain defined limits. The central bearing of this moving end of the frame is circled so as to permit each of the two rail wheels to move unevenly without interference with the frame. The motor is mounted on a shaft near the centre, in suitable bearings, and transmits the motion through helical gear and counter shafts to the bogie axle on each side. 3 claims.

## CORRESPONDENCE.

### Electric Light Fittings.

With reference to your note of the electric light fittings at the Hotel Metropole, Brighton, we are much surprised that Messrs. Benham and Frowde should have informed you so incorrectly of the true facts of the case.

The electric light fittings at this hotel were supplied by at least four different firms, none of whom were responsible for the designs, which were supplied by Mr. Alfred Holland, one of the directors. Our firm supplied the fittings for the entrance and main halls, drawing rooms, library and reading room, smoking room, staircase, principal corridors, standards for 42 principal bed rooms, and fittings for all bath rooms and many offices.

It can hardly be said, therefore, that the electric light fittings have been supplied by Messrs. Benham and Frowde, and we are informed that the above form certainly the majority of them.

B. Verity & Sons.

July 26th, 1890.

### Steno-Telegraphy.

In your paragraph on "steno-telegraphy," published in your number of July 18th, p. 71, you compare the latest form of Wheatstone's automatic instrument, such as now in use in England, and M. Cassagne's system. It is, nevertheless, a fact that this latter system—perfectly simple and reliable as it is—enables a single operator to punch his tape at a rate of speed not hitherto attained in telegraph work (100 orthographic words, or 200 shorthand, *i.e.*, phonetically spelt words, per minute).

This speed can be maintained for hours at a stretch. Moreover, the message is received in type.

This system is the only one, so far, which enables four persons, at the outside, to transmit 400 words per minute on a single wire. The difference between these four persons and the regular army of operators required for the same result with the Wheatstone system, is too important to be looked over by impartial minds.

The commercial aspect of the question can be summed up as follows:—

With two operators at each end of a line wire (four in all), M. Cassagne's instruments can send 400 words per minute. What would be the number of words sent by the Wheatstone in the same time, and with the same number of men?

L. H. Despeissis.

3, Rue du Mont Thabor,  
Paris, July 28th, 1890.

### Brush v. King. Brown & Co.

This judgment does not in the least surprise me, but I must confess to being greatly amused with the idea of so much money being wasted in lawyer's fees.

I have come to the conclusion that there is scarcely one valid patent in existence. This is not merely a hastily formed and speculative opinion, but is based on a most careful study of the patent specifications; a

study to which I have devoted my spare time during the last six or seven years.

Nothing can be further from my thoughts than to insinuate that any of the existing patents have been obtained by those who were not *bonâ fide* inventors. Those patentees have doubtless acted in perfect good faith, and without the least desire to appropriate the lapsed or uncompleted patent of their predecessors. But the fact remains that very many inventions on which patents are now held without dispute, are anticipated, and set forth in former specifications with far clearer language than Mr. Varley used.

It is obvious that my remarks are to be taken in a broad and general sense. Every invention must necessarily be new at some time or other; but it certainly seems very curious that many of the existing patents are to be found very exactly described in the specifications of twenty or more years back.

C. Purcell Taylor, D.Sc.

July 28th, 1890.

### Secondary Battery Manipulation.

I have not the slightest doubt that Mr. Barber-Starkey's communication on the above subject, which appeared in a previous issue, will be read by many with interest, and, probably, by himself and others, may be considered new; but this really is not the case, as the methods communicated by him are neither new nor novel, nor can they be considered any improvement in storage battery manufacture, according to present knowledge; in fact, this ancient method, as suggested by Mr. Starkey, is rather a detriment to success than otherwise, as I well know from practical experience, having as far back as 1882 manufactured, in conjunction with Dr. Woodward, the inventor of the Woodward system, storage batteries in numerous shapes and forms, many of which I have still by me as historical productions, showing some of the early work carried out in connection with this section of the industry; and, singular to say, amongst them is a cell in which the plates are divided by a compound packing of pulverised cocoanut fibre, boxwood, gypsum, &c., which was used by us as a separator of the lead plates. We also used many other forms of insulation, some of which were made from xylonite, Blake's embonita, vegetable ivory, and other fibrous materials suited for this purpose, which batteries, in various forms of manufacture, were publicly exhibited by my late firm at the "Engineering and Metal Trades Exhibition," held at the Agricultural Hall in the year 1883, and other exhibitions of more recent date; and as a record of experimental research, I may say that in our experiments we found that pulverised cocoa-nut fibre was the best adapted for the purpose we then had in view, the manufacture of a compact form of spongy lead plate which could be closely packed side by side without fear of buckling or short-circuiting the cell when used for traction work; but, after many experiments, this type of cell was abandoned by Dr. Woodward for his improved method, as now universally adopted by all makers of the Woodward cell, thousands of which are in daily use, doing good, active work in the United States of America, Canada, and other parts of the world; and in all probability in the near future a like effect may follow in this country. I may also say that I explained Mr. Starkey's proposed plan to Mr. Joel, and many others in the trade, years ago; and, if my memory serves me rightly, I believe patents were afterwards granted to Mr. Joel and also to a Mr. Tatham, the former for the use of cocoa-nut fibre separator, and to the latter for the use of sawdust and cellulose packings in combination with lead or other alloys for storage batteries, and as neither of these batteries have ever come to the front as a success, I presume the inventors came to the same conclusion as myself, that there was no value in the supposed inventions, or we should have heard more about them.

The use of a little permanganate of potash, carbonate of soda, sulphate of soda in combination with mercury,

if well mixed with the acid solutions, or even compounded with the lead when in a molten state (although not a new idea), has undoubtedly certain advantages—it assists formation, besides making the plates more homogeneous when used in combination with the Woodward, Planté, or other type of spongy lead plates.

As a matter of history, I may say that the use of carbonate of soda is a very old idea, and was recommended by me some years ago, and is duly recorded in the *English Mechanic* notices, and anyone interested in this subject can, by referring to same, find the report.

Moreover, I may mention that I supplied Mr. J. S. Sellon with specimens of this class of spongy lead compound type plate as far back as 1885; also Mr. Crompton in the year 1887—both of whom can testify to the fact, should Mr. Barber-Starkey require further verification of the fact—consequently further comment upon this point from me is unnecessary.

I may say that sawdust and all fibrous packings and separators have a tendency to absorb and retain moisture, and owing to their porosity will occlude gases, which is an advantage; but this method of packing the plates does not and will not prevent evaporation, as Mr. Starkey supposes, and the reason why he found his cells in such a placid state was simply because they had been kept idle and at rest, for it is well known by all experts that the evaporation of the liquid never occurs to any great extent, except in cases where the cells are either overcharged or have been too rapidly discharged when in use. Evaporation will then occur, which is caused by the expansion of the ethereal energy stored up in the shape of minute molecules consisting of “a something,” the component parts of which have yet to be determined by the aid of chemical science, which mysterious element may probably be a compound of etheralised ozone, or a species of azotic gas, most probably absorbed by the positive plate and held in combination with the oxide element contained in the cell. I have my own views upon the matter, but not being so well versed in chemical matters as I should like to be, I must leave the solution of this problem to our chemical *savants* to solve.

Arthur Shippey.

#### The Lineff Electric Traction System.

I read with considerable interest the careful and ably written report in your last issue by Mr. Kapp upon the new Lineff system of electric traction. The report itself is very fair and impartial—such as one might expect from the author—but I should certainly like to touch upon one or two points in this report, as well as the system described.

In the first place I feel pretty certain that, unless an absolutely rigid base support were given to the insulated rail sections, the inventor would speedily find them sinking down so much that they would be in contact at many points along the line with the internal conductor, and the galvanised iron strip would not be able to rise and make contact for the simple reason that it might be already wedged tightly between the conductor and the external rail, so making contact very effectually and permanently. Possibly I am doing the scheme an injustice from sheer ignorance, and when drawings appear this point may be shown to have had suitable attention. Nothing, however, will serve short of imbedding the insulated rail sections upon a good solid conduit, which also contains the conductor.

Even Mr. Kapp's apparently severe test of passing a heavy steam roller along the line does not altogether vouch for its efficiency; a single test like this does not compare practically with the ceaseless wear and tear of everyday traffic.

So long as a rigid connection is kept up between the conduit and insulated rail sections the device may be depended upon, but in proportion as this point is considered, so also are increased the difficulties of insulation.

Next, I must say that Mr. Kapp seems to have forgotten the old saying that refers to the weakest link of a chain; if any line has a minimum insulation resistance of 600 ohms and a maximum of 4,000, then the practical insulation resistance of that line ought, I think, to be looked upon as 600 ohms, and not as  $\frac{600 + 4,000}{2}$ .

An engineer is not altogether justified in reckoning on more than he can always and absolutely swear by; and as regards surface leakage, I fear this system (especially in our wet climate), would prove too wasteful for extended use.

Then, again, Mr. Kapp is, I think, a little unfair to the battery cars when speaking of the greatly increased weight to be carried.

From particulars of a large number of battery cars—all, indeed, that I could learn anything about—I found that the weight of the necessary cells complete was as nearly as possible that of the seated passengers at full load.

If the 20 passengers on the Lineff car weighed as much as the 3 or 4 tons that Mr. Kapp speaks of, then all I can say is, that they must have been in the prime of health and vigour—remarkably fine specimens, in short. A ton and a half of decently behaved cells ought to be ample for carrying 20 passengers along an average road.

One would wish very much for the sake of electric traction that one could see a prosperous future before such a system as that of Mr. Lineff: it is ingenious, it is novel (*pace* Mr. Holroyd Smith) and offers many advantages. But I fear the disadvantages would prove—in its present form—too serious to allow this method an extensive use. If practical service proves this feeling to be wrong, no one will be more pleased than

Frank B. Lea.

July 28th, 1890.

#### Secondary Batteries.

Referring to your article contained in your issue of the 25th inst. upon the merits of the Edinburgh paper upon “Storage Batteries,” it would appear that when speaking of the relative ampère-hours between the E.P.S. 7L cells and the ampère-hours obtained by Prof. Ayrton and his assistants, you lost sight of the fact that five instead of seven plates were used in the latter's cells.

Passing on to your reference to the “author's” concluding remarks, you think that further study and research into the chemical actions, &c., of the present storage batteries might be the means of increasing their efficiency.

I would, however, remark, for the benefit of those interested, that in my opinion any further labour in the direction of your suggestion would be time and capital lost, unless (after taking all the defects of the present batteries into consideration) improvements to the extent of 100 per cent. were obtained, which would be necessary to hold its own.

Progress.

July 29th, 1890.

[In the experiments at the Central Institution “7L glass cells” were used, containing *five* plates, but our clerical error does not in the least affect the sense of the article. We did not state that “further study and research into the chemical actions, &c., might be the means of increasing their efficiency,” but what we did say was that the promised “results on chemical investigations will be looked forward to with anxious interest by a large portion of the electrical fraternity,” and we maintained that the efficiencies obtained by Prof. Ayrton and his colleagues were, in our opinion, too high, and should not be relied upon in practice. Our correspondent must have had very sad experience with secondary batteries, and we cannot agree with his views as to an abandonment of all further research in this direction.—EDS. ELEC. REV.]

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## PROCEEDINGS OF THE BOARD OF TRADE.

THE Board of Trade has issued a report respecting the applications for orders and proceedings of the Board during the past year. There were 161 applications of which 45 were made by local authorities and 116 by companies or individuals, 23 relating wholly or in part to the County of London. The report states that a modified form of provisional order was made necessary, before the model form settled last year for the metropolis could be made applicable to districts outside the Metropolitan area. In accordance with the Acts all orders granted to companies have been with the full consent of the local authority for the district. When applications have been made by a company and a local authority, the preference in accordance with the rules has been given to the application of the local authority. A clause, however, has been inserted in the orders and licences which enables the local authority, if it thinks fit, to transfer its powers to any given company, with the consent of the Board of Trade; 67 provisional orders have been granted, chiefly to electric light companies, but many have been refused on the ground of not receiving the consent of the local authority; 12 licences have been granted to private persons, companies and local authorities.

A question having arisen as to the interpretation to be placed upon the portion of the Schedule of the Electric Lighting Act, 1882, defining local authorities in Scotland, the Board of Trade consulted the Scotch office, who were of opinion that in certain cases in which authorities in Scotland were authorised to supply gas, they were not the local authority for electric lighting purposes in the capacity in which they supplied gas, and would not be able to utilise the gas rates for electric lighting purposes in the event of their obtaining powers to supply electrical energy.

In the appendix to the report, the regulations are given for the protection of the public safety, also for the protection of the electric lines and works of the Post-

master-General, but these are word for word the same as those published for the first time in the REVIEW for August 30th of last year, and which formed the subject of a leading article in the same issue.

## CAPITAL PUNISHMENT BY ELEC- TRICITY.

UNDER date New York, August 4th, a Dalziel telegram read :—"All America is greatly excited about the fate of the murderer, Kemmler, who, it is now believed, will be executed to-morrow night." Probably all America is now more than satisfied; for after many months of alternate hope and despair, the poor wretch has been done to death. Our readers do not need reminding of the various episodes in this terribly realistic drama, during a period which must have entailed upon the condemned man an amount of mental anguish such as no mortal ever before endured, neither need we dwell upon the combination of circumstances which led to the adoption of electrical execution in New York State as the means of capital punishment. All the incidents which have resulted in the first and, it may be, the last, despatch of criminals by this agency, have been chronicled in our pages.

For several days past the newspapers have published sensational paragraphs concerning the preparations for the prisoner's end. His own bearing at the thoughts of his approaching fate was said to be that of a maniac, the tests of the death machinery were reported in terms of the most absurd nature, and the manner in which the culprit was to spend his last moments has been discussed to the veriest detail in language calculated to shock the most hardened reveller in the horrible.

These incidents are as nothing, however, compared with the doubtlessly grossly exaggerated and sickening reports of the execution itself; reports which, from their improbable nature, must be taken with a grain of salt until official accounts of the death stroke reach our shores.

Nevertheless, there is enough of truth in these highly coloured statements to send a thrill of horror throughout the world. That a *thrice*-repeated application of the current was necessary before the spirit of the condemned man left its earthly tenement, we do not for one moment believe, and with the numerous cases of accidental deaths from high-tension currents before us, we can scarcely think it credible that a carefully-planned scheme to deliberately kill should entail a lengthened period of suffering, when a chance contact has so often resulted in what has, to all intents and purposes, been instantaneous death; indeed, we have hitherto tried our best to prevent fatalities from electricity, and yet many lives have been unwittingly sacrificed. Still, so far as can be gathered from the reporters, it would appear that both in preliminary trials and at the final scene the machinery did not come up to expectation, and so far as it is possible to judge from the garbled versions given by the newspapers, we imagine that the engine was insufficient for its purpose. However this may be, we have to acknowledge the fact that although Kemmler is no more, his execution has been at once a bungle technically, and socially and politically a mistake.

However much we may wish to believe that New York, from humane desires, made electric execution the legal method of expiating one's crimes, there is only too much reason to fear that it was introduced and promoted until it became law by those who had political and personal motives to serve; humanity was ostensibly the plea, but the real reason is less fathomable, although perhaps not altogether beyond one's depth.

Even in the telegrams from America, on the day of execution, it is easy to perceive these conflicting interests at work, and, if we are not mistaken, a certain section of the electrical industry is more or less involved.

As we have previously remarked, it is useless to comment upon the use or abuse of the electrical machinery until authentic details of its performance come to hand, but at the same time we feel that some sort of protest should be brought against the indiscriminate statements which have been scattered broadcast throughout the land. If, as one of the electricians who was present says, "everyone in the room lost his head," how much weight are we to attach to the ghastly descriptions of Kemmler's contortions and apparently agonising sufferings? For our own part, we do not give credence to the statements that the first application of the current was ineffective, although, as the reports of those who were present are so conflicting, we shall probably never learn the exact truth of the matter.

Without expressing any sympathy with the murderer, who seems to have been of that type of man for whom no fate is too bad, it would seem that, as he had for more than a year been the subject for bandying scientific and legal argument throughout the different courts as to whether death by electricity was or was not "cruel, unusual, and unconstitutional," it would have met the ends of justice if he had been kept to penal servitude for life. Whether the effect upon the American

populace will be of a demoralising nature remains to be seen. The *Standard* thinks so, and that it can hardly be over-estimated. On the other hand, if the new law stands, it may have a deterrent influence on crime, and, if this turns out to be the case, the first electrical execution may not have been carried out quite without some compensating benefit for the horrors which were attendant upon its enactment. But it cannot be denied that the whole affair partook too much of the nature of a show, and the conversation reported to have arisen between doctors, warder and criminal would seem laughable were it not that the fate of a human being was the subject of the melo-dramatic episode. Indeed, one can scarcely get rid of the feeling that in some respects we are simply reading a criticism of an execution scene in a new and thrilling stage play. The utter lack of solemnity throughout the whole of the proceedings, the numerous assemblage permitted to participate in the tragedy, and the clumsiness with which the fatal stroke seems to have been administered, all combine to make one ask whether all this theatrical display can really have been an incident of to-day. That such was the case is only too true, but let us, for humanity's sake, hope that a like scene will never again figure in the theatre of life.

In the REVIEW for June 4th, 1889, we carefully considered, from various standpoints, the question of execution by electricity, and notwithstanding the impression which the bungling over Kemmler must have produced in the public mind, we do not think there is any need to modify anything we then said. We confessed that at first we were reluctant to entertain the idea of electrical means being adopted for the purpose. But this was mere sentimentality—selfish sentimentality; and when we came to reason calmly, we could not perceive that we had more cause to object or complain than would the hydraulic engineer if death by drowning were proposed, or the cutlers of Sheffield, if the guillotine were to be brought into use in this country. The trend of civilisation, moreover, being towards lessening rather than increasing the horrors of capital punishment, it behoved us to consider whether death by electricity could not be made immediate and sure, for the rope has not been infallible. We thought so, and again we assert our belief that in proper hands there need be no hitch and no fear of failure with the electric current.

The *Standard* on  
Electrical Executions.

YESTERDAY's leading article in the *Standard* concludes as follows:—  
"The demoralising effect which such a scandalous scene as that enacted yesterday must have upon a large portion of the population of New York, and, indeed, of the United States, can hardly be over-estimated. The publication of minute accounts of every detail of what took place made the thrice-repeated efforts to stamp the life out of Kemmler visible to the whole nation, and fed the desire for sensationalism already too largely pandered to in the New World. The American public was yesterday thrilling with anxiety, not to hear that a brutal murderer had paid the penalty of his crimes, but to learn how long, and with what particular circumstances of horror, an alternating current is in destroying a human being.

The criminality of the man to be executed was not thought of. Kemmler was simply looked upon as a subject who might fairly be used for the great experiment. That the existence of this unwholesome and degrading sentiment shows any special depravity on the part of the New Yorkers we do not desire to assert for a moment. Electricity for the last few years has been the toy of the American people, and they have employed it for every conceivable purpose. At last some ingenious mechanist suggested that it should be used to get rid of criminals. The idea seems at once to have captivated the minds of the State Assembly, and they proceeded to adopt the suggestion. No doubt they soon grew persuaded that they were acting in the interests of humanity, though, in truth, they were lending themselves to a popular craze, and were merely endeavouring to show that there was no end to the wonders of electricity. Such levity, had it been conscious, could only have been described as inhuman; as it is, we must condemn the lack of judgment which prevented the members of the two Houses realising that they were prostituting the sacred work of legislation to the vilest sensationalism. Had the infliction of the death sentence by hanging outraged public opinion by constant failures, and had it thus become necessary to devise some new method, it might have been possible to find an excuse for the action of the Legislature. No such considerations, however, existed to influence them. The law, as already remarked, was simply and solely the outcome of an electrical craze. When this was the origin of the Act, it could have no other effect but that of demoralising the whole tone of the community in regard to capital punishment. Even had the process worked well instead of badly, it must have tended to make people look upon executions as sensational exhibitions of the powers of modern science. As it is, it is impossible to be sure that torture of the most excruciating kind has not been added to the death penalty in New York. But will popular feeling in the States allow the recent alterations in the law to stand? We doubt it. The Americans are, we believe, not less humane than their kinsfolk on this side of the Atlantic, and the sickening spectacle of yesterday will kindle a feeling of horror and disgust which neither Congressmen nor Senators will be able to disregard."

Electric v. Steam  
Traction for Elevated  
Railways.

THE *Financial News* published an article on the 25th ult., entitled "Electricity as a motive power." It was mainly based upon the experiments of Mr. Moss, of the Manhattan elevated railway of New York, and the results to the casual observer are calculated to lead him to the belief that electric traction is a fraud. It seems, however, that Mr. Moss must have got hold of some electrical plant belonging to a prehistoric age, as may be gathered from the following:—"Leaving Thirtieth Street, for instance, up a gradient of about 1 in 60, the horse-power exerted by the driving engine indicated 395, while at the same time but 7.6 horse-power, as indicated by a dynamometer, was being exerted to pull the train, showing less than 2 per cent. of the power of the engine transmitted to the train at that instant." We would like to know what kind of conductors were used for conveying the current and the state of their insulation, but on these points we find nothing. The *Financial News* is not improving the chances of com-

mercial men taking to electric traction by quoting figures which give one side of the matter only, but perhaps the policy of that journal lies in an opposite direction; in any case another paper, the *Railroad Gazette*, shows, from Mr. Moss's own figures, that propulsion by electricity, instead of being four times as expensive as steam traction for the elevated railway, shows a decided economy.

THUS runs the verdict of the jury which last Saturday met to consider the death of Private Sanford, who while watching a cricket match was killed by lightning, at the same time several companions also were severely injured. To say the least it is surprising that a body of men under the guidance of a coroner, who we presume to be an educated man, should return so anomalous a verdict. To appreciate a verdict of that character we must go back to the days when the ducking stool and the moot hall were time honoured institutions. Doubtless there would be many peculiar verdicts when the supernatural and mysterious influenced the mind, but one would have thought that we, in the 19th century, knew a little better. As showing the logical conclusions of the jury, the conduct of a Doctor Trask, who restored animation in the injured men, was highly praised, and owing to his exertions one man who would have died was restored. We are afraid that the worthy doctor must have defeated the ends of Providence by his timely act.

What Constitutes  
an Invention.

THE following extracts are from the opinions of three of the best American judges, and will probably suffice to define what constitutes a patentable invention, which is interesting to everybody:—

An invention, in the sense of the patent law, means the finding out, the contriving, the creating, of something which did not exist and was not known before, and which can be made useful and advantageous in the pursuits of life, or which can add to the enjoyment of mankind. In other words, the thing patented must be new; and it must be useful to an appreciable extent, though the measure of that usefulness is not material. Any degree of utility appreciable by a jury is sufficient, upon the question of utility, to sustain a patent. . . . . Invention is the work of the brain, and not of the hand. If the conception is practically complete, the artisan who gives it reflex and embodiment in a machine is no more the inventor than the tools with which he works. Both are instruments in the hands of him who sets them in motion and prescribes the work to be done. Mere mechanical skill can never rise to the sphere of invention. The latter involves higher thought, and brings into activity a higher faculty. Their domains are distinct. The line which separates them is sometimes difficult to trace; nevertheless, in the eye of the law, it subsists. The mechanic may greatly aid the inventor, but cannot usurp his place. . . . . The simplicity of an invention, so far as being an objection to it, may constitute its great excellence and value. Indeed, to produce a great result by very simple means, before unknown or unthought of, is not unfrequently the peculiar characteristic of the very highest class of minds. A subject matter to be patentable must require invention; but it is not necessarily the result of long and painful study, or embodied alone in complex mechanism. A single flash of thought may reveal to the mind of the inventor the new idea, and a frail and simple contrivance may embody it. Some inventions are the result of long and weary years of study and labour, pursued in the face of abortive experiments, baffled attempts, and finally reached after the severest struggles; while others are the fruit of a single happy thought.

## THE EDISON PHONOGRAPHIC TOY.

(A BANK HOLIDAY RHAPSODY.)

FROM the giant mind of the mighty Edison has sprung the crowning boon and blessing to men and infants. Monday last week saw the lists open for subscriptions to the Edison Phonographic Toy and Automaton Company, Limited, and Wednesday witnessed their close. In that time, if all went well, £300,000 of capital was paid in to Messrs. Brown, Jansen & Co., to the credit of the undertaking, of which £270,000 is to benefit the vendors and £30,000 the shareholders—perhaps? A military baronet holds the chair, with another soldier and three civilians as colleagues on the board, and there are five several firms of brokers to the company. Brokers live on commissions; commissions depend on transactions in shares, so it looks as if these were expected.

If you want to bore a man or boy try to instruct him; if you want his love, although temporarily, it may be, amuse him. For years we have done our best to instruct the public, and, accordingly, have not amassed a fortune. Oh! that we had earlier perceived the right path, become speaking dolls and sold ourselves for £270,000, less commission to brokers.

Perhaps the promoters would have done wisely to have rested their hopes ostensibly on the doll business, and not have referred in the prospectus to the utilitarian possibilities of the invention, unless they had proceeded further, and touched upon the more important uses which must infallibly follow. We are to have "talking automata in bar rooms, restaurants, cigar shops, and show-rooms of all kinds, to call the attention of customers to particular articles." Why stop at this dull, prosaic view, when the vista into which even our dull mental vision can penetrate is so glorious? With what rapture must the Wizard of Menlo Park have peered into the future of the talking doll after a few years of development. We can only suppose that his well-known modesty kept him from putting it all in the prospectus, or else the directors cut it out to save expense in printing and postage.

The uses enumerated in the above quotation seem ill-chosen. Surely Messrs. Spiers and Pond understand human nature better than to supplant their pleasant young ladies by talking automata? There is a sympathetic electric current induced in sexes of opposite signs by nature herself, and the most modish robes and a three guinea head of real hair hanging over the glass of bitter, and saying "tuppence please, thank you," would fall stale, flat, and unprofitable upon the ear of the dude. Again, "What is the next article?" is irritating enough to the average male, but spoken by an automaton, possibly with an American twang, would raise his evil passions to such a pitch, that the said figure would be in a parlous state, if not actually demolished by the umbrella of the irate one; in which case no enlightened jury would return a verdict other than justifiable dollicide.

But think of that poor man who, having lost his wife, never slept again because he missed the curtain lecture. Had he but possessed a phonographic image, into the "body" of which (price 12s.) the dear departed had once spoken the words of admonition, he could have laid it reverently on the pillow by his side, and let it off nightly at the appointed hour. The same old tale reiterated each bedtime would have been monotonous enough to send the most hardened insomniac soundly to sleep.

Not only will advertising media, but religion be extended. The poor district which cannot afford an incumbent could go to "between £3 and £4" for a phonographic automatic parson. The lights of the Abbey and St. Paul's, of the Tabernacle and the Temple, can have an illimitable sphere of action, and let us hope a handsome honorarium, at per annum or per hour, for preaching all day and every day at phonographic bodies, which can be despatched by parcels post through the length and breadth of the land, ensuring eloquence and sound doctrine, and setting free to take

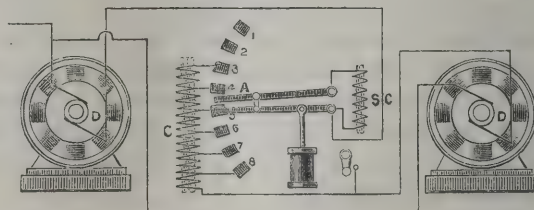
their place in the battle of commercial life, alike the high church curate and the young baptist minister, to the detriment of tennis, no doubt, but to the good of the community.

Fancy an age of phonographic *prima donnas* in every village schoolroom, and the more than ever automaton chairman reeling out well-considered speeches at annual meetings. Or say, Mr. Gladstone is indisposed in consequence of an adverse vote, would his verbosity be diminished? Not at all. Up stands his *alter ego*, and the exuberant phrases flow. An Irish member is sick; his double takes his place with the extra advantage that no calls to order would have any effect; no Speaker could stop him unless the bauble were for once made useful to literally knock his arguments to pieces.

That we do not spin this article out into many volumes is simply that our space is limited. It is a misfortune that scientific commercial companies always choose the days between the issuing of the technical papers for the bringing forward of their prospectuses, and we are debarred from helping them by our praises in time to aid their subscriptions. All we can utter is: "Too late, too late; you cannot enter now."

## METHOD OF SYNCHRONISING ALTERNATE CURRENT MACHINES.\*

IT has been the common practice to make the multiple connection of alternating current generators or motors after the impulses are observed to synchronise, various devices being used for determining the times of synchronism. In the method, which is the invention of E. W. Rice, jun., of Lynn, Mass., two or more alternate current dynamos or motors which are developing or running on circuits of approximately the same potential difference, may be coupled in multiple at any time without any special preliminary observation. In a few words, the invention consists in bringing the two machines



METHOD OF SYNCHRONISING ALTERNATE CURRENT MACHINES.

to synchronism by interposing a reactive coil in the armature circuit between the machines to be connected. In order that the operation of the method may be the more easily understood, it may be explained that the electrical activity displayed in this reactive coil depends upon the amount of current flowing through it. This amount in turn depends upon the difference in the phases of the currents passing to the coil. The effect of this action is to retard or accelerate one or the other of the machines until the phases of the impulses coalesce, because this is the condition of least resistance in the combined circuits. Referring to the diagram which illustrates the method, D is an alternating current dynamo, and D' is another and similar dynamo or motor. These are connected, as shown, with a variable reactive coil, C.

Switch arms, A, are insulated, one from the other, but are connected through a smaller reactive coil, S, C. These arms can be moved over the numbered contact plates. Assuming that the dynamo, D, is running, and

\* Western Electrician.

it is desired to divide its work with the machine, D', or in case it is desired to throw on the machine, D', as a motor, the method of procedure is as follows:—The arms, A, which, when the machine, D', is idle, are supposed to be resting on the contact pieces, 1 and 2—that is, open circuited—are moved, so that the lower arm connects with the contact piece, 3. In this position the working circuit of the machine, D', is closed with the circuit from the machine, D, through the reactive coil, C. This coil, with the lower arm in the position just mentioned, has all its wire in circuit, and is therefore developing its maximum counter electromotive force. Now, by moving the levers from contacts to contacts, a current from one machine or the other is permitted to act gradually so as to accelerate or retard the machines and bring the alternations into perfect synchronism before connection is made through the ordinary conductor of practically no resistance or reaction. If it is desired that one machine shall take a larger portion of the load than the other, the reactive coil, C, may be left in the circuit connecting the second machine. The function of the smaller reactive coil is to prevent sudden fluctuations of the current when the arms are moved over the contacts.

### THE INTERNATIONAL EXHIBITION OF MINING AND METALLURGY.

LAST year a suggestion was brought forward that an exhibition should be held in London this summer for the purpose of demonstrating the great advances which have of late years taken place in mining and metallurgical practice. The idea, which was favourably received in different quarters, has culminated in the present exhibition which was opened at the Crystal Palace, on Monday last week, by Lord Thurlow. The exhibits are distributed throughout the galleries and the palace building, whilst the machinery in motion is erected in a special building built at the north end of the palace. Most of the Colonial Governments are officially represented, that of New South Wales, which occupies the south nave and a large portion of the galleries, having the largest and most interesting collection of different minerals. Many English and foreign mining companies show a number of mining and metallurgical exhibits.

It was expected that several important electrical firms would be *en evidence*, but only a few are represented. The Planet Electrical Engineering Company has a small installation for lighting the machinery hall. The plant comprises a Crompton continuous current dynamo, driven by belting from a Rigg rotary engine. The machinery hall is lighted by 20 Planet arc lamps of 6 ampères, the lamps being arranged two in parallel. Mr. Lars Bristöl shows several of his miners' lamps having accumulator cells. The main feature of these is the fact that the glow lamp is covered by an external thick glass dome which, if accidentally broken, throws the lamp off its holder and interrupts the circuit. It is claimed that by this means the possibility of any explosive gases being ignited is entirely removed. Messrs. J. Davis & Son, of All Saints' Works, Derby, exhibit, among other articles, protector fittings for incandescent lamps, ceiling roses, ammeters, voltmeters, switches, electric blasting apparatus, &c. Various electric firing batteries, galvanometers, electric wires and electric mining appliances are to be found on the stand of the Cotton Powder Company, Limited, and similar apparatus are also on view by Nobel's Explosives Company, Limited. Messrs. Woodhouse and Rawson United, Limited, have an interesting collection of electric bells, batteries, lamps, &c.

Of engineering firms, Messrs. Davey, Paxman & Co. have the largest display. They show, among others, a 40 H.P. horizontal engine and two horizontal boilers of

40 H.P. This engine drives a line of countershafting from which the machinery in motion is mainly operated. There are also on view an 8 H.P. compound portable engine, an 8 H.P. single cylinder portable engine, a 6 H.P. girder engine, an "Essex" boiler, &c. Messrs. Dick, Kerr and Co. exhibit a Griffin gas engine. The only glass case in the Machinery Hall contains a display of some useful goods manufactured by Messrs. W. H. Willcox & Co., including their special make of wire-bound hose, such as is used for the delivery of petroleum from ships and by the Fire Brigade. Leather belting is shown in various forms, as well as a number of other articles in daily use in mining operations.

The exhibition will remain open until the middle of October.

### SOME DEFECTS IN PHYSICAL TERMINOLOGY.

By PROF. A. E. DOLBEAR.

WE abstract the following from the New York *Electrical Engineer*:—In the subject of electricity the lack of definitions in the terminology has led to a great deal of confused thought, but our actual knowledge of the character of electricity is much greater than many suppose it to be. Maxwell and others have asserted that whatever it may be it is not energy, while others, as represented by Preece in his late presidential address, assert that it is energy. Curiously enough Maxwell declares that it cannot be energy because electric energy is a *product* of electricity, E, into a current, C.

Eidlund and some others have thought electricity to be identical with the ether, while still others have imagined it to be a fluid, or two fluids, or some kind of matter with the fundamental property of matter—namely, *mass*, left out. It is not very difficult now to see how such varied conceptions arose. An electrified body affects the space about it, or, as we now say, it produces an electric field which is known to be a stress in the ether, and that implies a strain in the electrified body. It is also known that such stress is propagated in the ether with the common speed of ether waves—namely, 186,300 miles per second. The speed of this movement has been measured by so many, and in so many ways, that there is no doubt about it, and since the experiments of Hertz there is no room for doubt as to the existence of the ether.

What we now know is that states of stress in the ether are propagated at a definite rate in it, which rate depends not upon the source of the movement but upon the property of the ether to transmit movement; so, whether heat movements or electrical movements are antecedent makes no difference. We find no difference in perceiving the relation between the vibratory molecular motions and the resulting waves in the ether, but here is a precisely analogous case of electrified molecules and the ether propagating a motion, which implies, if anything, that molecular motion is the source of the ether displacements. One person will give chief attention to what is going on in the electrified matter, and another person to what is going on in the ether, and they come to different conclusions as to the nature of electricity, while a third person who notes their discrepant notions concludes that no one knows anything about it. What we call electricity originates in matter, and there is no evidence whatever that it ever originates apart from it. As Rowland has somewhere said: "It begins in matter and ends in matter." The conditions for its origination are differing and interfering molecular motions, whether in a thermopile, a galvanic battery or a dynamo; the conditions for its transference are a continuous material conductor, for it cannot traverse a vacuum. The effect upon the ether

we call an inductive effect; and just as in heat phenomena we have a transference and a transformation, so is there also in electrical, both a transference and a transformation. In heat phenomena, where matter is placed in the *thermal field* so that the ether undulations fall upon it, the matter is heated. Likewise, when matter is placed in an electric field the matter is electrified. The cases are exactly analogous, and one is therefore justified in making the terminology appropriate to the phenomena; and whenever there has been a transformation in the motion, another name ought to be adopted and not let the old one do double duty. If molecular motions of any kind be called electricity, then it is not proper to call any effects in the ether by that name. If the effects we study in the ether be called electricity, then do we need a name for what takes place in matter, for one is the effect of the other.

If one adopts the doctrine of the conservation of energy, and also that the matter of the earth is practically a constant quantity, it will lead him to conclude that all the varieties of energy are due to the various forms of motion that matter may have. If, also, one perceives that motion of any kind, at any place, implies antecedent motion, he will not feel the necessity for looking for hyperphysical explanations for any physical phenomena. For instance, when one sees the light and feels the heat from an electric arc lamp, knowing the nature of both the light and heat as being but particular forms of motion—one in matter, the other in the ether—he could logically look for nothing but some kind of motion that had been transformed to produce such effects. It is entirely immaterial what the character of the motions may be that produce electrical effects—that may remain to be determined by experiment—just as in the case of heat after the work of Sir Humphrey Davy and Count Rumford, it was then settled what the *nature* of heat was—namely, a molecular motion of some sort and not an entity. It is only within a few years that the character of the motion has been determined. In like manner we may say that we know what the *nature* of electricity is—that it is also molecular motion of some sort to be experimentally determined.

There are numerous reasons for thinking it to be a rotation as distinguished from a vibration. One of the chief of these comes from a study of electro-magnetic effects in the ether. It is generally agreed that this magnetic effect in the ether is of the nature of a whirl, or rotation, and in numerous treatises these whirls are pictured, but I do not remember to have noted that anyone has pointed out that a whirl in the ether implies a rotation of a molecule, for a simple reason that an undulation in the ether implies a vibration of the molecule. To me this appears to be necessary, but whether the motion be that or some more complex kind does not so much matter—it will be discovered in time.

There is one more important matter I want to allude to, and that is the expression first used by Maxwell, namely, "Light as an electro-magnetic phenomenon." Waiving for the time the criticism that light, being a physiological phenomenon, is therefore entirely inappropriate here, there still remains this fact that the ether waves from heated bodies move in straight lines, and unless deflected by the reflections and refractions of matter, will continue indefinitely on in the same straight line, making the *field of a heated body* as extensive as the universe; while the field of an electrified body depends upon the proximity of masses of matter, and practically is always limited in extent, and the observed lines are always curved. So if the two kinds of waves were really parts of the same movement, what is called a ray of light would seldom or never be found to move in a straight line for any considerable distance. If, on the other hand, the wave that originates in a vibration continues in a straight line only so long as it moves in homogeneous ether, and has its place of vibration changed by passing through a space of ether that has been electrically warped, as we experimentally discover to be the case, it would seem to follow that the two kinds of motion

in the ether are fundamentally unlike. Either can exist without the other, and therefore they ought not to be called by the same name.

## EDINBURGH EXHIBITION.

(Continued from page 126.)

No. 162.—*The Electric Engineering Corporation, Limited.*—This exhibit includes a Statter-Brunton constant current dynamo as supplied for driving the tramways in the Via Flaminia at Rome. This machine is fitted with Statter and Brunton's patent automatic regulator and maintains a constant current of 30 amperes with a maximum E.M.F. of 750 volts at 750 revolutions. The machine is shown at Edinburgh driving three motors in series. These motors are placed on the stand. One of them drives a D.D. compound wound dynamo having an E.M.F. of 60 volts and a maximum current of 75 amperes at 1,300 revolutions. This machine is used to light the stand. Another of the motors is run light. They are fitted with constant current regulators which maintain an absolutely constant speed from full load to no load. A third motor is combined with a hoist and illustrates the adaptability of the constant current system for transmission of power for such purposes. The hoist may be started, stopped and regulated with extreme nicety. The system is fully protected by patent. The exhibit also includes a high speed engine with automatic governor acting directly upon the cut-out. This engine has single cylinders, since the available boiler space at the exhibition is low. An Atkinson 2 H.P. nominal gas engine is shown combined with a D.C. dynamo. This is used to drive arc lights in parallel the lamps employed being the Statter patent arc lamp.

The Corporation also exhibits a 20 inch projector fitted with patent diverging gear. The projector is made in brass and gun metal and complies with Admiralty specification. For the Executive Council it has equipped the electrical tramway running from the Caledonian Station to the Exhibition. Each car is driven by a 15 H.P. motor, the driving power being derived from two 30 unit Statter dynamos.

The trolley line exhibited by this corporation at the exhibition is  $\frac{1}{4}$  mile in length and travels over undulating ground, the highest point being 30 feet from the ground, and the lowest 15 feet. There are two trains, each consisting of a locomotive and four cars. The speed maintained is 5 to 6 miles an hour and the trains are prevented from any possibility of collision by the employment of a dead section in the conductor. The current is derived from the D.M. dynamo exhibited at the stand.

## HIGH VERSUS LOW-TENSION.

THE report of the Electricity Committee for the St. Pancras electric lighting, to which we briefly referred in our last issue, is, in several respects, instructive reading, and from the fact that the recommendations contained therein emanate from so high an authority as Dr. Hopkinson, it is of considerable value. But although there is every reason to regard the report as being founded upon a sound basis, it cannot be unreservedly accepted, in the absence of information showing how the recommendations are arrived at. Dr. Hopkinson, in reporting upon the schemes proposed by Prof. Robinson and Mr. Gordon, the one being for a continuous current 200-volt system, using three wires, and the other (that of Mr. Gordon) a 1,000-volt alternating system, states:—"If the distance to which the bulk of the supply is to be transmitted is about one mile, the two systems are about equal in cost; if it exceed a mile the alternating current at 1,000 volts is

cheaper than the continuous current at 200 volts, for less distances the continuous current is cheaper." As in the case of St. Pancras, the bulk of the work lies at much less distance than a mile from the station, the 200 volts system is recommended as being the more economical. There is, we think, a fairly general consensus of opinion as to the commercial advantage of a low-tension system for short distances, and therefore, as we stated, we may accept the recommendation as being sound. Still more interesting would it have been, however, if we could have had Mr. Gordon's explanations for his advocacy of a high-tension alternating transformer system, a system in which accumulators cannot be used, and in which the transmission of motive power is practically (at present, at least), impracticable. This latter point—the transmission of power—may not, however, be one of any great importance, unless it can be shown that there is, or is likely to be, any large demand in the district for the supply of motive force.

The reference in the report to Major Cardew's opinions on the advantages and disadvantages of the high-pressure transformer system, as used by the Chelsea Company, do not appear to be of any material value, as these opinions really do not compare the advantages and disadvantages of the high and low-pressure systems, they simply state what the high-pressure system will do, and not what the low-pressure system will not do; much of what is said applies equally to the two systems, as, for example, when it is stated that "It is also a simple system to work, and the dynamos are simple, and can be made in easily replaceable parts."

Messrs. Latimer Clark, Muirhead & Co. express the opinion—"we are certain that low-pressure continuous current system will be found the most economical, satisfactory, and enduring"—and they adduce certain reasons for their belief; these, however, are, we think, no reasons at all; they say that certain good results have been obtained from the low-pressure system, and give figures in support of their assertion, but with reference to the high pressure they say *we are not aware* that any alternating, high-pressure, or transformer system, could show anything like the same economy; "if they cannot prove that the high-pressure system is not economical they cannot be competent to express an opinion on the relative merits of the two."

From the point of view of cost only the low-tension system, as recommended against Mr. Gordon's scheme, shows a considerable difference, a difference which the report states "placed the scheme (Mr. Gordon's) quite outside the favourable consideration of your committee."

### RENARD'S VOLTAIC CELL.

THIS cell, the invention of Commandant Renard, will, it is claimed, give a considerable amount of energy in a very short space of time, or it will yield the same total amount of energy, gradually decreasing, with a duration of discharge proportionately increasing. The arrangement is of the bichromate of potash type, and its novelty consists in:

(a) The substitution of hydrochloric acid for some of the sulphuric acid.

(b) The suppression of the alkaline base, the bichromate being replaced by chromic acid.

Each cell consists of an elongated tube made either of glass or ebonite. The positive electrode is furnished by a very fine platinised silver tube (a carbon electrode is found to be unsuitable), and the negative electrode is a thin rod or wire of zinc.

The liquid used in this cell is composed of a mixture of two liquids, A and B, each of which is itself a mixture.

(A) consists of chromic acid and water, 0.530 of acid to 0.770 litre of water.

(B) consists of a mixture, in variable proportions, of hydrochloric acid and sulphuric acid.

If commercial hydrochloric acid be employed, it must be brought to a certain strength (18° Beaumé) by the addition of a little water. The requisite strength of sulphuric acid is obtained by mixing 0.450 kg. of acid at 66° with 0.800 litre of water, and the result should show 290° Beaumé.

The symbol, B, may be conveniently used in order to indicate the strength of the liquid, B, in percentage of sulphuric acid, thus B<sub>20</sub> indicates that the liquid contains 20 per cent. of the acid.

It is stated that the total electric capacity of the cell does not vary or behave in any erratic way, and that many experiments show that the available energy per second is practically quintuple of that which can be obtained with the same apparatus charged with the bichromate of potash and sulphuric acid liquid of the ordinary bichromate battery.

The following are figures given by Renard in support of these contentions:—

Strength of the liquid.			Maximum current.
Mixture of liquid A with	B <sub>0</sub>	.....	8.50 ampères.
"	"	B <sub>20</sub>	7.40 "
"	"	B <sub>40</sub>	6.80 "
"	"	B <sub>60</sub>	5.20 "
"	"	B <sub>80</sub>	3.50 "

Instead of sulphuric acid, sulphate of soda may be employed in liquid B, but the effect of the use of this salt is to reduce the total available energy per litre of liquid.

The best proportion in which to employ the constituents of the liquid is shown by the following table:—

No. of expt.	Joules obtained.			Composition of liquid.
	In the expt.	Per litre of liquid.	Per kilo. of liquid.	
1	44,900	200,000	170,000	{ HCl at 11° ... 200 cc. CrO <sub>3</sub> ..... 40 gr.
2	48,000	215,000	176,000	{ HCl at 11° ... 200 cc. CrO <sub>3</sub> ..... 60 gr.
3	52,200	233,000	185,000	{ HCl at 11° ... 200 cc. CrO <sub>3</sub> ..... 80 gr.
4	56,900	253,000	197,000	{ HCl at 11° ... 200 cc. CrO <sub>3</sub> ..... 100 gr.
5	56,000	250,000	184,000	{ HCl at 11° ... 200 cc. CrO <sub>3</sub> ..... 150 gr.
6	46,100	205,000	144,000	{ HCl at 11° ... 200 cc. CrO <sub>3</sub> ..... 200 gr.

The liquid employed in No. 4 experiment should be the best for general use, for it gives 253,000 joules per litre. This liquid, however, has the inconvenience of being a little viscous, and of sticking to the surface of the zinc—effects which conspire together to produce a diminution of energy which is quite appreciable. In actual practice the liquid which is found to be most suitable is that used in experiment No. 2.

It is unnecessary to amalgamate the thin zinc rod or wire which forms the negative electrode. By reducing the diameter of this electrode, the density of the electricity at its surface is increased, and at the same time the consumption of the metal per second and per unit of surface is reduced.

The great activity of these cells necessitates the provision of a considerable cooling surface, for there is a large amount of heat generated; this fact has determined the adoption of the tubular form of cell.

**Electric Light at Fareham.**—The introduction of the electric light into Fareham is likely to be attended with some difficulties. A memorial signed by 50 inhabitants was presented to the Local Board on Friday last against the erection of electric lighting poles, on the ground that they would disfigure the town. It appearing, however, that an action at law was already pending in reference to the matter, the Board decided to await the issue of events.

## THE KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING STATIONS.

THE district over which the Kensington and Knightsbridge Electric Lighting Company has the right to supply electrical energy extends from Kensington High Street on the west to Albert Gate on the east, and from Hyde Park and Kensington Gardens on the north to the line of the Metropolitan Railway on the south. The original supply station erected by the company at Kensington Court commenced work in 1887, and has been continuously in operation since that time. It has been fitted with machinery capable of supplying between 20,000 and 30,000 lamps, and a second station at Chapel Place, Knightsbridge, has been constructed, which is able to supply another 20,000. The mains of the company have been laid in most of the principal streets of the district, and exceed 10 miles in length; they are all underground, and consist of concrete culverts made in the footways, having openings with removable covers opposite every second house. The conductors are bare copper strips resting on insulators, and the engineers claim that all future necessity for disturbing the surface has thus been avoided.

The system employed is the low pressure continuous current, assisted by accumulators to form a reserve of power and as a means of keeping the supply of current absolutely constant, and avoiding the chances of a breakdown. During the three years and a half the company has been in existence only one failure of the light has taken place, which occurred soon after starting. The working of this station, it is believed, is more economical than any other central station either in England or abroad; but, unfortunately, not being furnished with exact figures or data, we are not in a position to verify this statement.

The customers have paid for their electricity by meter record, and they appear to have been satisfied with the system of measurement.

The following particulars were issued by the company, and show the present condition of their system:—

Number of lamps ...	...	...	...	15,130
"    houses ...	...	...	...	178
Mains laid in miles	...	...	...	10½
Horse-power	...	...	...	750

The amount of power can be easily increased to 2,000 H.P., sufficient to supply a total output of 100,000 lamps, which is considered to be the full amount required for the district.

On entering the station at Kensington Court while the plant is running, it cannot but be favourably noticed that the moving machinery is working in comparative quietude, and that the absence of noise and clatter is in marked contrast to the din prevailing at several other stations we have seen. The engines being coupled direct on to the dynamos, there is a corresponding gain in compactness and economy of floor space over machinery driven by long ropes or belts.

The buildings comprise a main shed, whose floor is some feet below the level of the street, in which are erected the boilers, engines, and electrical apparatus, accumulator galleries on an upper floor, as well as on the ground floor, together with sundry store-rooms and offices.

There is ample floor space for a further and large extension of plant, should the requirements of future demands necessitate providing for an increased supply. The company, however, considers that the present equipment will suffice for the coming winter, and that unless an unexpected demand arises to strain the limits of the effective output of the machinery, no heavy alterations to this station will be requisite for some time to come, nor to the other station in Chapel Place.

Each engine and dynamo is fixed to a common bed-plate. The engines are of the Willan's type, and are provided with fly-wheels to ensure greater steadiness in driving the dynamos, which, as before mentioned, are coupled direct. The Kensington Court station is equipped with four engines of 200 H.P., driving the same number of large Crompton dynamos, furnishing

currents at 200 volts pressure, suitable for the three-wire system (on which principle the whole of the circuits will eventually be worked), and also three smaller engines of 80 H.P., each driving a single magnet upright Crompton dynamo. The steam power is developed by three sets of boilers of 250 H.P. capacity, constructed by the Babcock and Wilcox Company.

Massive leads are taken from the dynamos to switchboards erected in a small gallery specially set apart for the purpose, and by means of these every manipulation connected with charging, coupling, and other regulation of the currents is performed. The entire board has been designed in a thoroughly workmanlike manner, the mechanical engineer showing himself as prominent in the construction of the details as the electrician does in those points where his special knowledge is necessary. Instance the switch used for adjusting the number of accumulator cells for general regulation—the lever employed for working this switch has much of the character of those that are fixed in the signal boxes on railways for controlling the signals and points, and is of sufficient strength to withstand any wear and tear or rough usage that it will be likely to meet with. The electrical contacts present large surfaces, and much care and forethought has been exercised in ensuring good contacts between the parts when they are intended to operate.

In order to prevent, as far as possible, the loss between the terminals of the secondary batteries, the copper leads to the switchboard have a heavy section in the form of an H girder, which gives a very rigid conductor of ship-shape appearance.

There are several sets of accumulators, and of these two are placed in a stable at some distance from the charging station to assist in maintaining an even potential throughout the mains. A set is an aggregation of 56 separate cells of the Howell type arranged in series. Each cell of the battery contains 61 plates, and their dimensions are 8½ inches square by ¼ of an inch in thickness. The receptacle in which these 61 plates are placed is of lead with burned joints, and considerable attention has been paid to secure good insulation for the battery; each cell stands upon a plank painted with acid-proof pigment, and this is again insulated from the main frame by glass insulators. All timber in the supporting frame is painted with the above acid-proof application; while, not to neglect any means for preventing leakage, the contractors have paved the floor of the accumulator room with a special compound of bitumen and slate dust, a composition not only acid-proof but possessing good insulating qualities.

The normal output of the accumulators, or what may be better called the average discharge per hour, is 250 amperes, and the maximum allowed under contracts which must not be exceeded is 500 amperes. It would only be on an emergency that they would be discharged at the latter rate.

Aron meters are in use for measuring the current supplied from the stations, and the officials employed there speak very highly of their accurate performance in registering the precise amount of current consumed within a limit of error, so it is said, of less than a half per cent.

The Crompton system of underground mains, in use throughout the district, has been in successful operation for some years. The conductors are bare copper, supported on glass insulators in concrete culverts, under the footways. The conductors are composed of copper strip, one inch wide by a quarter of an inch thick; in some cases two or more strips are superimposed, supported at intervals in the culverts on glass insulators, which are arranged in sets, each set placed under a surface box having a removable cover, so that the insulators can be examined or replaced, or connections made to adjoining houses without disturbing the surface of the footway or roadway. These copper strips are strained tight, and held up by arrangements which can only be properly described and shown with the help of drawings. Such straining or fixing apparatus must be employed on straight runs, at certain intervals, depend-

ing on the weight of the conductors, and at points where the conductors deviate considerably from the straight line.

As the company, represented by the secretary and the contractors and their assistants, have been unsparing in their pains to render the installation of the electric light in their district as big a success as possible, it is to be hoped that the public, who occupy the houses along the route of the company's mains, will avail themselves to a large extent of the facilities thrown in their way, and use the electric current in such quantity as will suffice to somewhat recoup the Kensington and Knightsbridge Company for the heavy outlay to which it has been put in starting its system.

## ELECTRIC TRACTION AT SALZBURG.

[FROM A CORRESPONDENT.]

A VERY interesting electrical tram line for the conveyance of passengers will be opened in a few days at Salzburg for public traffic.

To an almost perpendicular declivity of the Rönchberg there is affixed a cable line, worked by electricity, with an exactly vertical track of the cars. The considerable height of the installation (75 metres) and the extensive arrangement for the electric working, secure for the undertaking a significance, though in its nature and outward form the name "passenger conveyance," in the sense of the lifts at hotels, would be most suitable.

As far as the shore of the Salzach the spectator perceives the slender iron framework of the line, with a double track for an ascending and a descending seat. The lower station contains, in addition to the entrance and departure platforms, the battery chamber, containing 126 accumulators of large make, supplied by the Swiss Oerlikon firm, and which supply the electrical energy required for the ascent. The electricity for charging the accumulators is supplied by the dynamos of the Salzburg electrical works, which have been in operation for some years. For this purpose a special cable lead has been laid down, so that the accumulators can be charged during the daytime, when the dynamos are not required for the supply of light. It is therefore hoped that this installation will considerably increase the remunerative character of the works.

At the upper station is the electromotor which acts by a simple transfer to rollers placed in juxtaposition, over which runs the bearing rope of the travelling seats.

The entire installation has been executed by the firm Siemens & Halske, who constructed the Salzburg electrical works and then handed them over to a limited liability company. The height of the lift, as already signified, is 75 metres, the weight of a travelling seat is 1,200 kilos. Each seat can accommodate 12 passengers, who in a few moments can be raised to the summit of the Rönchberg.

The fare proposed is 20 kreuzers each person for the ascent and 10 for the descent, which, with regard to the small distance traversed, cannot be regarded as very moderate. A restaurant and an extensive park are projected on the level of the upper station.

**Tenders for Lighting Sofia.**—The Foreign office has issued the following notice, dated August 2nd:—"With reference to the notice published in the middle of last May respecting tenders for lighting the town of Sofia by electricity, a despatch has been received at the Foreign Office from her Majesty's Agent and Consul-General in that city, stating that the adjudication will take place in the course of the next six weeks, and that any British firms desirous of competing should lose no time in communicating with Monsieur D. A. Zenow, of Sofia, or directly with the Mayor of that city, Monsieur D. Petkoff."

## REVIEWS.

*The Electrical Engineer's Pocket-Book.* By H. R. Kempe, M.I.E.E., A.M.I.C.E. 1890. Crosby, Lockwood and Son, London.

The aim and object of this handy book of reference cannot be better explained than by quoting the author's own words. "In compiling this book my aim has been to produce a book which should, as far as possible, truly accord with its title, viz., a pocket-book of useful "modern rules, formulæ, tables and data"—the matter selected being such as is required for daily use in practical electrical engineering and its various applications to the industries of the present day. So multifarious are the data required, that every person engaged in the practice of electrical engineering must have experienced the want of such a manual."

The information which the author gives has been (he remarks) "carefully condensed, and only that which, in the practical experience of myself, and of others with whom I have been associated, has been proved to be of constant value, has been included." The book extends to about 250 pages, and includes numerous illustrations. It is divided into twenty-one sections, as follows:—(1) Weights and measures; (2) Units; (3) Temperatures; (4) Electro-Chemistry, Primary Batteries, and Accumulators; (5) Electro-Metallurgy; (6) Current; (7) Resistance; (8) Capacity; (9) Galvanometers; (10) Fault Testing; (11) Wire; (12) Insulated Wire; (13) Electric Light Leads; (14) Electric Light, Dynamos, and Motors; (15) Rules and Regulations; (16) Telegraph Apparatus; (17) Telephones; (18) Miscellaneous; (19) Mathematical Tables; (20) Foreign Money; (21) Dictionary of Technical Terms.

It immediately strikes one with surprise that in the above subdivisions of practical electrical engineering, no mention whatever is made of submarine telegraphy. The omission is evidently intentional, as, beyond one mention in the index, "Cable cores, size of," this important subdivision of electrical engineering is apparently entirely omitted, save that, in "Miscellaneous," is found a diagram and note for "sheathing wires for cables," otherwise "submarine," does not appear in the index. Of course, there are formulæ and descriptions of "fault-testing," but as these are applicable to ordinary insulated electric wires, they cannot be credited to submarine work exclusively.

Under "Temperature" will be found—an arrangement very handy for reference—formulæ for the effect of temperature in the electrical resistance of various objects, such as copper, German silver, platinum silver, platinoid, gutta-percha, and India-rubber. The latter is given, it is believed, for the first time in any book, the writer not being aware of this useful information having been previously published. Although manufacturers are aware of the behaviour of India-rubber under the influence of temperature, yet this information has been invariably kept to themselves; the subject, generally speaking, being a sealed one. Is it because so little is known about it? At page 20 will be found a table of great value on this point: "Dividing coefficients for correcting the observed resistance of India-rubber at any temperature to 75° Fahr." Comparing this with a similar table for gutta-percha, it will be found that whereas G.P. alters from 1.00 at 75° to 1.982 at 66°, India-rubber only varies from 1.000 to 1.244 at 66.5°; a very marked difference in the influence of temperature on the two insulating substances. The author, in referring to India-rubber, is presumably understood to refer to "pure" rubber only, as *vulcanised* rubber is nowhere referred to. This is somewhat remarkable, considering the various qualities of this material, and the prominent position it now occupies as an insulator for electric light cables.

Under the heading of "Capacity" will be found formulæ for finding the inductive capacity of wires insulated with gutta-percha; and it is added, "for India-rubber the values are about 10 to 15 per cent. less," but as to the capacities of other material no mention will be found.

Nor is any allusion made to cables insulated with paraffin or other substances whose inductive capacity is considerably less than that of gutta-percha. As these forms of cables are very largely used abroad and also at home, especially for telephonic purposes, it is a matter of regret to find no mention made of them. But there appears to be an entire omission of any form of telephonic cable, whether underground or aerial, even the four-wire post-office form, and the over-ground "twist" seem to have been omitted. Under the same head of "Capacity" will be found a very useful and valuable "Loss of Charge" table showing approximate percentage of charge lost in a cable after 20 seconds' charge and one minute's insulation, corresponding to various values of F.R. ("capacity per knot  $\times$  insulation per knot"). The test for percentage of loss is an exceedingly valuable one, and with an ordinary electrometer the condition of an insulated wire can be immediately judged without the necessity of calculation. Too little value has hitherto been placed upon this form of testing, and where definite results are required without the mathematical values, then the "loss of charge" test is the quickest and best of those known.

Under the heading of "Electrification," page 59, there are some remarks of so valuable and so perfectly reliable a character that a reproduction is desirable, as the particular attention of those engaged in correct testing should be drawn to it.

"The galvanometer deflection in the insulation test should be perfectly steady; unsteady reading, provided connections are well screwed up and battery is in good condition and well insulated, means a faulty cable. The deflection will gradually decrease whilst the battery is kept on, the decrease (called *electrification*) being rapid at first and then gradually slower. The decrease will be quicker at a low than at a high temperature. It is greater with India-rubber than with gutta-percha." "It is of very great importance to have both ends of the cable core well trimmed, and quite dry when testing. The trimmed ends should be dipped in melted paraffin wax." To those engaged in testing and wishing to obtain reliable results, better instructions cannot be recommended.

In the section given to "Wire" will be found a large amount of very useful information, commencing with the "standard wire gauge," to which a note is appended. "This gauge is the only legal standard wire gauge for the United Kingdom." It is, however, not the only one in use, for the B.W.G. is still very largely employed. A comparative table of wire gauges—that is, the S.W.G., the B.W.G., and the American B. and S., is very handy; but the B.W.G. can be found on referring to "Glover's" useful tables, of which a large abstract has been made.

The section on "Insulated Wire" concludes with the following "general observations": "Too much care cannot be taken in making joints; a defective joint, although it may not for a time so far lower the insulation as to cause a serious leakage of current, is almost certain to go completely bad sooner or later. Similarly, an insulated wire which has an insulation resistance of several megohms (an insulation which is amply sufficient for working purposes, provided it remains constant), would be almost certain to fail sooner or later, if its normal insulation were several hundred megohms."

In the section "Electric Light Leads," the Board of Trade limit is given at 2,000 ampères per square inch of section, but calculations are usually made upon the 1,000-ampère limit; this is apparent in some tables given further on. It is pleasing to find that reference is frequently made to the work done by the late Robert Sabine, for in electric lighting several of his tables are to be found. The instructions given by him for the mechanical tests (see p. 131) for insulated electric light wires are worthy of consideration; but Sabine was one of those who worked before their time.

There are several other points to which attention might be drawn, notably, to a large amount of very useful information included in the "Miscellaneous" section, but space hardly permits of much further

reference. However, the tables at the end of the work will be found most useful and valuable, and tend to render the book very handy and complete.

The index is of an excellent character, and much time and labour must have been spent in rendering this as complete and correct as possible. So far as examination goes, it is about as good an index as can be met with. The work concludes with "a concise dictionary of electrical and technical terms in general use," which will be found of advantage to the many who have not been electrically brought up. As a very useful and handy help to those engaged in the various electrical industries, this work is strongly commended, and the author may fairly be congratulated on the successful carrying out the aims professed in his preface.

G. E. P.

#### *Galvanic Batteries, Accumulators and Thermo-Batteries.*

*A Description of the Hydro and Thermo-Electric Sources of Currents with especial reference to practical requirements.* By W. PH. HANCK. (Die Galvanischen Batterien, Accumulatoren und Thermo-säulen Eine Beschreibung der hydro und thermo elektrischen Strom Quellen mit besondern Rücksicht auf die Bedürfnisse der Praxis). Third edition. Vienna, Pest, Leipzig: Hartleben.

This work forms a volume of the "Electro-technical Library," issued by the publishers. The author, indeed, says in his preface, perhaps too modestly, that batteries must now seem to the electro-technician merely the out-grown "diseases of the childhood of applied electricity." The substitution of the dynamo for the battery has been indeed a revolution. It has taken electrical research out of the hands of chemists and handed it over to mechanics, and probably all the results of the change have not been favourable to scientific progress. Herr Hanck mentions that many a promising improvement has disappeared from the scene or has sunk into a subordinate position, and that his readers will have become suspicious of inventions which have come across the Atlantic or the Channel, and cautious concerning French discoveries, though guaranteed by the names of celebrities. In the present addition, in place of dazzling novelties, the author has inserted merely matter which has stood the test of experience.

Accumulators naturally occupy a considerable space. As regards thermo batteries, the missing link has not yet been found which should connect the furnace at once with the battery without the costly intervention of the steam engine and the dynamo or their equivalents.

*The Electric Light and the Lamps, Carbons and Illuminating Bodies hitherto employed.* By Dr. ALFRED RITTER VON URBANITZKY. (Das elektrische Licht und die hierzu angewandten Lampen, Kohlen, und Beleuchtungskörper.) Third Edition. Vienna, Pest, Leipzig: Hartleben.

When a reviewer has found it possible to make favourable mention of a book it is always satisfactory for him to find that the public has endorsed his judgment so that successive editions of the work have been found needful.

In the present case a thorough revision and rearrangement of the subject matter has been found necessary in consequence of the rapid progress of electro-technics. The present edition is in many respects a simplification. Thanks to the unceasing activity which is being displayed both in the theoretical and the practical sphere, a new light has been thrown on many points which were till lately a subject of doubt and controversy. The description of glow lamps, which in the two earlier editions occupied merely 13 pp., now extends to upwards of 50, although the author evidently eschews superfluous verbiage.

We think that electricians who already possess a copy of the first or second edition, will find it advantageous to add the present impression to their libraries.

## LINEFF'S ELECTRIC TRACTION SYSTEM.

THIS letter came in too late to take its place in our correspondence columns:—In your issue of last week you published a letter of Mr. Frank B. Lea on my new magnetic conductor.

I am much pleased with the impartiality of Mr. Lea's criticism, although I must beg leave to differ in several of the points touched upon.

To begin with, his fear that "the insulated rail sections would sink so much that they would be in contact at many points along the line with the internal conductor" is perfectly groundless. For this to happen two things are necessary: the breaking of the earthenware supports or tiles which are embedded in asphalt, and also the crushing of the latter around the exposed and blind rails. Considering that the crushing strain of both materials is very high, it is easy to demonstrate that the power required to crush in the conductor is enormous, compared even with the severe mechanical test applied by Mr. G. Kapp (heavy steam roller), and the existence of such heavy weights in public streets is simply out of the question. A good concrete bed for the conductor is, of course, a condition *sine qua non*; but so it is for the running rails and the paving between them, and consequently this does not involve any extra outlay. Sketches of my conductor have appeared in most of the technical papers, and Mr. Lea will be able to judge for himself that very careful attention has been paid to the mechanical requirements. The magnetic rails are not only supported by such a strong material as earthenware embedded in asphalt, but are, moreover, securely interlocked by the latter, and all engineers know what a capital foundation for machinery this material makes, and how it takes up vibrations and strains.

If Mr. Lea had been present at an experiment I made with two lengths of magnetic rails imbedded in asphalt, when it took about four hours for two men with sledge hammers to detach the rails from the asphalt, he would have more confidence in the resisting power of my conductor.

Mr. Lea is quite right in refusing to recognise any similarity between the action of a heavy steam roller with the "ceaseless wear and tear of every day traffic;" but he is wrong in assuming that the latter is more dangerous to the efficiency of my sealed conductor. The experiments I have made in this direction lead me to conclude that this ceaseless rolling of cart-wheels will keep the asphalt round the rails compressed, thus preventing any possibility of leakage. Moreover, the wear and tear of asphalt is a quantity well known, and large cities, like Paris and Berlin, use it almost exclusively for paving.

With all respects to Mr. Lea's electrical training, I must decidedly contest his criticism as regards surface leakage. The well-known theory about the weakest link of a chain cannot be applied to surface leakage, as the latter does not depend on the quality of insulating material, but merely on the state of dryness, or otherwise, of the surface. Telegraph engineers know the fact well, and while getting in dry weather an insulation resistance of, say 20–30 megohms per mile, this resistance will fall to perhaps 200,000 ohms in wet weather. Of course, it would be absurd to record the yearly average insulation of the line either at the former or the latter figures, but it must be some mean quantity depending on the number of wet and dry days during the year.

About the joke as to the extraordinary weight of passengers in Mr. Kapp's calculations, I will say nothing. I should like only to point out that the car referred to was intended to accommodate 52 passengers, similar to those used by the West Metropolitan Tramway Company. If Mr. Lea will take into account the extra weight of car and motor necessary for traction by accumulators, he will find the weight of the latter mentioned by Mr. Kapp quite in accordance both with American and continental practice.

In conclusion, I must add that, if one had to mind

all friendly "fears" and "doubts," no invention would be possible. But I believe Mr. Lea wishes me well, and declares that no one would be more pleased than himself if such fears should prove illusory in actual practice, and this I hope to demonstrate to him very shortly.

ALEX. L. LINEFF.

ELECTRICAL TRADES SECTION LONDON  
CHAMBER OF COMMERCE.

A MEETING of the section was held at Botolph House on Wednesday, Mr. Crompton in the chair.

The first business before the meeting was to receive the resignation of Mr. Trotter as technical correspondent.

Mr. CROMPTON regretted very much that Mr. Trotter, on account of other duties, was obliged to withdraw from the office. His position as chairman had only been made possible by the capability of Mr. Trotter. He thought the thanks of the section were due to him for the able manner in which he carried out technical matters relating to the section.

A vote of thanks was passed, and Mr. TROTTER responded.

Major FLOOD PAGE said with reference to the appointment of a successor, he would have a proposal to lay before the section at the next meeting; in the meantime, he hoped the matter would be left over.

A resolution was passed in accordance with the wishes of that gentleman.

## OVERHEAD WIRES.

The section next considered the reply of the Board of Trade to the resolution passed by it at its last meeting with reference to clauses 9 and 12 of the Board of Trade regulations relating to the insulation, &c., of cables, and the suspension of conductors.

The CHAIRMAN incidentally remarked that the effect of the regulations had been, in one case, to run up the cost of a certain cable used for street lighting from £28 to £75 per mile. The reply of the Board of Trade amounted to a blank refusal to reconsider the matter.

Major FLOOD PAGE moved, and it was resolved, that the chairman be requested to draw up a short statement of the disadvantages and hindrances to the electrical trade of some of the Board of Trade regulations, and to send it to the secretary of the Institution of Electrical Engineers, together with the resolution of the section already signed, and a copy of the Board of Trade's letter, and a request for the appointment of a committee of the Institution with a view to meeting a committee of the section for the purpose of considering and inducing the Board of Trade to reopen the matter.

## PATENT LAW REFORM.

The report of the Manchester Chamber of Commerce was laid before the section. The report points out that the Patent Law at present allows of considerable abuse, *i.e.*, bogus inventions are very frequently patented in order to prevent the possibility of other inventions of a similar class; and it suggests that the law should be so amended as to make such abuse impossible.

The SECRETARY said the Chemical Section of the Chamber had considered the matter, and recommended the appointment by the council of a representative committee of the various sections interested in the matter, with a view to making some practical suggestions.

A MEMBER thought the law of disclaimer should be abolished.

Another MEMBER pointed out that the section was only interested to a very small degree.

It was resolved to address the council to the effect that should it think fit to appoint a committee, the Electrical Section would assist as far as it can, and be prepared to appoint delegates.

## THE FRANKFORT ELECTRICAL EXHIBITION.

The SECRETARY laid on the table a copy of the regulations.

Major FLOOD PAGE took occasion to point out that the date for sending in exhibits has been extended in favour of foreign exhibitors to September 30th.

## THE EDINBURGH ELECTRICAL EXHIBITION.

The SECRETARY read a letter from the committee, requesting the section to send in the names of jurors nominated by it.

It was resolved to address the committee something to the following effect:—The Section regrets that the committee of the Edinburgh Electrical Exhibition did not avail itself of the opportunity of the presence of the Institution of Electrical Engineers in Edinburgh to confer as regards the appointing of jurors; that as the section is informed that it is not the intention of the Institution of Electrical Engineers to appoint jurors, it regrets that it will be unable to do so; and further, the section points out the inconvenience arising from the lateness of the application, when most of the members have already made arrangements for their holidays, &c.

## RAILWAY RATES.

Mr. TROTTER produced the following draft classification issued by the Board of Trade for those items of the merchandise traffic which specially concern the electric trade, and observed that on the whole the trade had reason to be satisfied.

	Old classification.	Cleaning House.	Class in de osited schedule.	Class proposed by Chamber of Commerce	Classes recommended by Board of Trade.
Dynamos in cases...	2	3y	Omitted	2	2
Batteries, packed...	3	3	3	2	3
Sulphuric acid .....	4	Special	Omitted	C	not dealt with
Telegraph batteries	3	3	Omitted	3	3
Electric storage batteries .....	2	2	3	2	2
Cables .....	4y	4y	4	3	3
Carboys, not glass, empty, not returned .....	4	4	Omitted	4	4
Carboys, empty, glass .....	3	4	Omitted	4	5
Cars, tramway .....	Special	Special	Omitted	Special	carriage class
Castings, iron, malleable .....	1	1	2	1	1
Castings, iron, steel, light .....	1	1	2	1	2
Castings, steel .....	3y	1	3	1	3
Telegraph insulators .....	1	1	Omitted	1	1
Sheet iron annealed	1	1	Omitted	1	not packed B
Mouldings .....	3y	3y	Omitted	2	3
Telegraph posts ..	1	1	Omitted	1	B
Reflectors, glass ..	4	4	5	4	4
Sponge cloth .....	2	2	Omitted	2	3
Steel bars, bundles ..	2	2	Omitted	2	2
Telegraph cable ..	4y	4y	Omitted	3	3
Wire, cotton covered	2	2	4	2	2

## THE LIGHTING OF SOFIA.

The secretary produced a letter from the Foreign Office, the purport of which will be found in another place. The proceedings then terminated.

**Electric Light in West Africa.**—We are informed that the first installation of electric light in West Africa was started on May the 31st last, at the Gie Apponto gold mine on the Gold Coast. A Siemens compound dynamo supplies 15 lights to the stamp mill house, engines and boilers. The installation, which has caused a great sensation in the colony, was set up by Mr. J. A. R. Milton, formerly with Messrs. Woodhouse and Rawson.

## NOTES.

**Electric Lighting at Bromley.**—The local syndicate for the electric public lighting at Bromley, Kent, has resolved that it will not favour any particular company in the carrying out of their scheme, but will employ its own engineer to get out estimates and then invite tenders from some of the best firms.

**Bristol and the Electric Light.**—The question of the desirability of adopting the electric light for the illumination of the streets is occupying a good deal of attention at Bristol. The Electric Lighting Committee recently visited London and Chelmsford, and at their last meeting decided to proceed to Bradford.

**Electric Lighting at Woking.**—A public meeting was held on Tuesday evening to consider the desirability of lighting the town by electricity. After a discussion a vote was taken, 24 against 5 being in favour of lighting the town. It is probable that a further meeting of ratepayers will be held on the subject.

**Lighting of the Hotel Metropole, Brighton.**—With reference to Messrs. Verity's letter, Messrs. Benham and Froud say, "We wish to take the credit for nothing more nor less than the work we actually executed. If you will kindly refer to the memorandum we sent you, with our brief notice, you will see we describe them as the 'principal fittings,' and so undoubtedly they are, comprising (1) the 'electric sunlights' for the whole of the magnificent suite of three public dining rooms; (2) the whole of the private sitting room electroliers; (3) the principal vestibule electroliers; (4) several hundreds of portable table pillars for the bed rooms. We have not stopped to enquire whether one, four, or forty other houses also supplied fittings, nor have we stated that the designs were ours, the drawings having, in point of fact, being supplied to us by Mr. Holland."

**Electric Lighting in St. Pancras.**—A special meeting of the St. Pancras Vestry was held on Wednesday night to consider the report of the committee mentioned in our last and present issues. An amendment was proposed, referring the report back, but this was negatived, and the report was finally adopted.

**New Spanish Cable.**—The *Standard* says that the new Spanish Minister of War, General Azcarraga, has resolved to proceed at once with the laying of a telegraph cable between Spain and her stations on the coast of Morocco.

**Appointment.**—We hear that Mr. A. R. Bennett, formerly of the National Telephone Company, has been appointed engineer-in-chief to the Mutual Telephone Company.

**Electric Traction at Chiswick.**—The members of the Chiswick and Brentford Local Boards have expressed themselves so satisfied with the Lineff magnetic conductor that they have given their consent to its adoption on such portions of the West Metropolitan Tramways as are under their respective jurisdictions. The only remaining local authority whose consent must be obtained is the Hammersmith Vestry, to whom two alternative schemes will at once be submitted. The first refers to the application of the Lineff system to the line from Young's corner to the Uxbridge Road Station terminus; and the second from Young's corner to Hammersmith Broadway. As soon as their consent is given, the work of laying down the conductor from Kew Bridge either to Uxbridge Road station or to the Broadway will be at once proceeded with. The West Metropolitan Tramway Company has instructed Mr. C. Nicholson Lailey to prepare a report on the reconstruction of the line.

**Central Station at Verona.**—A central electric light station is now being erected in Verona, according to the plans of Mr. Eugenio Vitale, the Italian representative of Messrs. Schücker and Co., of Nuremberg. The station will be completed in a few months, and will have a capacity of 3,000 lamps. Of these, 30 arc and 1,200 incandescent lamps are to be put into operation this month. The three-wire system of distribution, in conjunction with feeders, has been adopted, the conductors being placed overhead. The steam plant has been supplied by Messrs. Tosi & Co., the conductors by Messrs. Pirelli & Felten and Guilleaume, and the electrical apparatus by Messrs. Schücker. The station is the property of a co-operative society.

**Lyons National and Colonial Exhibition, 1892.**—The project of a great national and colonial exhibition has just been adopted in France, to take place in Lyons during the year 1892. Two sections will be international: silk and electricity.

**English and French Submarine Cables.**—Mr. Raikes, in the House of Commons, in reply to Mr. Henniker Heaton said: I have to state that a substantial profit will no doubt result from the purchase of the submarine cables between this country and the Continent, but it would be premature at present to estimate the amount of that profit in view of the condition of the cables. As the House is aware, some of these cables are very old, and it is possible that before long a considerable expenditure may have to be incurred in renewals. Not only so, but the necessity for additional plant has arisen, and a large sum will be spent in the course of the current financial year on a new cable and land line. The number of words in Anglo-French telegrams has risen from 13,376,333 in the year to March 31st, 1889, to 15,495,791 in the year to March 31st last. Other telegrams have passed over the Anglo-French cables, but I am not able to give separate particulars with regard to them. In answer to a further question by Mr. Henniker Heaton, Mr. Raikes said that he had no knowledge of what had passed in the French Chamber. It was possible that it might be necessary there to ask for a vote for a cable between France and England, but it was not necessary to ask Parliament for the money for a cable to France.

**The Institute of Medical Electricity, Limited.**—This Institute has been removed to larger and more commodious premises at 35, Fitzroy Square, W. Increasing work and the need for being nearer the great medical centres of Harley Street and Wimpole Street induced the directors to make the change. They have taken one of the old-fashioned substantial residences on the Grafton Street side of the square, and it contains many large, light, and airy rooms, well adapted to the purposes of the institute. The drainage has been entirely renewed, and the house decorated from attic to basement. The apparatus has been carefully removed from the old quarters at 24A, Regent Street, and new has been added to it, so that greater facilities for electrical treatment are now available. We understand that increasing use is being made of treatment by "cataphoric medication," or the passage of drug solutions through the skin by means of electric currents. This method of obtaining strongly localised action has been developed from its experimental stage, and first brought into practical use at the institute under the auspices of Dr. Arthur Harries and Mr. H. Newman Lawrence. It has already proved very successful.

**Edison's Greatest Work.**—Dr. Lassar stated at the Medical Congress, now held in Berlin, that Mr. Edison intended, through his medical adviser, to communicate a novelty in the shape of an application of electricity for the removal of stone. This will be glad news, if true, for the operation for this disease is reckoned amongst the most painful; and if Edison completes this work, he will have achieved his greatest success, for the name of him who has alleviated pain goes down to posterity ever blessed.

**Tenders for Electric Lighting.**—Estimates are requested for lighting the public streets and buildings in Helston (Cornwall) by gas, oil, or electric lights, per annum, for the Town Council. Tenders to be sent to Mr. J. G. Plomer, town clerk, by 16th inst.

**A Record in Dividends.**—The *Gazette* notifies the payment from the estate of the late Mr. Ex-Alderman Hadley, 5, Knight-riding Street, of a first and final dividend of one-sixth of a penny. The connection of Mr. Hadley some years ago with a submarine cable scheme will probably be still fresh in the memories of our readers.

**Opposition to Electric Lighting Poles.**—The Fareham Electric Light Company, having been made the subject of an indictment in respect of the poles which they have recently erected in the town, a mass meeting of ratepayers was held on Tuesday. A resolution was passed expressing sympathy with the company in its endeavours to introduce into the town a better and a purer light, and condemning the action of a privileged few in endeavouring to thwart the wishes of the ratepayers. The electric light company, it may be added, have entered into a contract with the Local Board, under which they are to light the streets of the town for a period of three years for the annual sum of £500, or £30 less than the price at present paid for gas. This matter has been referred to on another page.

**Prevention of Vibration in Lamp Filaments.**—To prevent excessive vibration of filaments of incandescent lamps, a method has been employed in which the loop end of the filament is steadied between metallic posts set into the glass bulb. When, however, this arrangement is used, frequent contact between the filament and these metallic posts soon weakens the former, removing, as it does, small particles at a time, and the life of the filament is materially reduced. It has also been found that the filaments, by their frequent contact with metallic posts, form grooves in the latter by melting away the material. In experiments made with the view of producing stops which will effectually accomplish the desired result, and at the same time insure the full life of the filament, George R. Lean, of Boston, has found that the stop or stops must be made of material which will not melt and that is non-combustible; and also that a stop composed of the same material of which the filament is made is best suited for the purpose. He, therefore, provides stops of carbon, they being secured to the apex of the bulb, and located adjacent to each other to receive between them the filament. When the air is exhausted from the bulb, a small short tube of glass is fitted in the hole at the end. The outer end of this tube is afterwards sealed. To secure the stops in place, the inner end of this tube is closed, and the stops are secured in the closed end.

**Pole-Finding Paper.**—Since the time when we first had occasion to notice Wilke's pole-finding paper, Dr. Oscar May, of Frankfort, who is the sole proprietor and maker of the paper, has improved the form in which it is issued to the public. No change has been made in the material itself, but the sheets of prepared paper being bound up with a stiff cover, instead of a limp paper back, renders its present form of issue much more convenient for carrying in the pocket, at the same time giving more protection to the paper, and thus preserving it in good working order for a longer period. Bound up with the pole-finding paper will be found instructions for its use, and claims as to its advantages over the expensive instruments which have hitherto been in general use for the purpose of detecting the direction in which a current is flowing. The indications being absolutely correct, even with as low a potential as a single volt, Wilke's P.F.P. affords a handy and speedy means of determining the direction of a current, or for the detection of leakage in conductors and other kindred faults. The paper can be obtained from Berend & Co., Fore Street, E.C., the sole representative of Dr. May in this country.

**The Southend Electric Tramway.**—Messrs. Crompton and Co., Limited, are running an electric tramcar along the pier at Southend. The engine, boiler and dynamo are situated under the arches near the entrance of the pier, and the current is conducted along the central rail for three-quarters of a mile down the pier. The car holds about 40 persons, and travels at the rate of about sixteen miles an hour, doing, in some three and a half minutes, the journey which takes nearly fifteen minutes by horse traction. The line, which has been carried out in a very expeditious manner, was certified by Dr. Hopkinson on Friday last, when he expressed himself highly gratified at the result. On Saturday afternoon, after a few trial runs, it was handed over to the Local Board for public use at four o'clock. Immediately, large numbers of people availed themselves of it, and all day on Monday (Bank Holiday) the car was well patronised. As this is a highly satisfactory exhibition of electric traction situated a short distance from London, it will no doubt be visited by everybody interested in this particular work. Messrs. Crompton inform us that they are willing to give any information to those who require it and will call at their offices before proceeding to Southend.

**The Lane-Fox Patents.**—It seems that Mr. Lane-Fox and his advisers are not going to get their own way without a struggle; perhaps not even then. Sir Frederick Bramwell, Mr. Swinburne, and Mr. Kapp are all agreed that the claims of the Lane-Fox Company cannot be sustained, and the Kensington and Knightsbridge Electric Lighting Company has opened communications with several others for the purpose of co-operating together for the formation of a defence association. The proposed basis for this, which we should be glad to see carried out, is as follows:—1. To defend any action that may be brought against any of them by the Lane-Fox Electrical Company, who are threatening to commence actions in respect of the letters patent owned by them, and alleged to cover the system of supply above mentioned. 2. To take such advice and collect such information as may be necessary for the protection of the rights of the several members of the association to use the system of supply above mentioned. 3. Supply companies to subscribe a minimum of £50, contractors £25, and owners of private installations £10, to be called up as required; this would entitle members, thus constituted, to claim that the association should defend any action to the extent of the funds subscribed, and any additional amount which may, from time to time, be voted in general meeting, which might be brought against them by the Lane-Fox Electrical Company, in connection with the above-named claims. 4. Should further funds be required, the members are to be called upon to subscribe, in the ratio of the sums above mentioned, according to their respective denominations. 5. Any member of the association may retire at any time, in which event this association shall no longer be under any liability to defend any action which may have been brought, or may be brought, against the member in question.

**What the Americans Say.**—The *India Rubber World* states that Mr. Ferranti has surmounted the difficulty of jointing cables to carry 10,000 volts. This is scarcely borne out by a note which appeared in our last issue.

**The Phonographic Doll.**—The *Financial News* of Wednesday says:—"Rumours being current that there was some hitch in connection with the Phonographic Doll Company, our representative made inquiries at the offices of the company yesterday, and was informed by the secretary that the statement as to the company having been withdrawn from the public was incorrect. This gentleman declined to give any further information, and in reply to a question as to whether the company had gone to allotment, remarked that he was not going to be 'pumped.'"

**The Manufacture of Cables in America.**—Of the manufacture of cables in America, a rubber journal of that country says:—"Some day, perhaps, America will take a hand in submarine cable work, but the day seems far distant, as she looks on so complacently while cables are being landed on her shores or on those of neighbouring countries, and makes no attempt at participating in the labour and the profits."

**The Etiquette of Journalism.**—We have noticed from time to time complaints emanating from our English contemporaries respecting the cool manner in which articles have been abstracted from their columns and reproduced across the herring pond as original matter. We, too, on various occasions, have detected many productions of our own appearing in American journals as editorials, but we have rarely come across a more audacious case of piracy than that of which the *Electro-Mechanic* has been guilty, viz., the publication of our leading article on "Lightning Protectors" from the REVIEW of May 16th, without the slightest recognition of its origin. We are fain to believe that the source of papers which English journalists think may prove interesting to their readers is invariably acknowledged, unless through some oversight of rare occurrence, but we cannot give the American technical press credit for the same honesty of purpose.

**Kemmler's Execution.**—The following particulars of the end of Kemmler, the first man to suffer the extreme penalty of the law by death from an electrical shock, were telegraphed, on the 6th inst., to the *Standard*:—"The convict Kemmler was to-day executed by electricity at Auburn Prison, New York. The execution, which took place at seven o'clock in the morning, was a trying spectacle, as, owing either to imperfect regulation of the strength of the currents or faulty contact of the electrodes, the convict's death was not instantaneous. There were present in the chamber where the execution was carried out twenty-six persons, including several physicians, scientists, and officials. The unhappy man showed great nerve, placing and adjusting himself in the execution chair with perfect calmness. The lethal shock continued for eighteen seconds. Two minutes after the current was suspended there were evidences of respiration. As soon as possible the current was renewed and then cut off, but again respiration was evident, and a minute or two afterwards saliva issued from the mouth, the chest heaved, and a wheezing sound came from the throat. The shock was then applied for the third time, and Kemmler was pronounced to be dead. The physicians say that he was unconscious from the moment of the first shock. Smoke appeared at the back of the body, where the flesh was burnt by the intensity of the current. The voltage at the first shock was 1800. The duration of the first shock was seventeen seconds, after which it was supposed that Kemmler was dead. The spectators, however, were then horrified by the respirations being renewed, the entire body being racked in the efforts of the organs to resume their functions. The current was then started again. A convulsion was marked on the first application of the electric current, and the culprit was declared to be dead in 13 minutes from the first stroke. The flesh on the back was burned, and there was also a spot on the top of the head. The doctors who made the autopsy agree that unconsciousness set in immediately, and declare that death was apparently painless, notwithstanding the slight defects in the apparatus, which required a second contact to ensure death. There was a considerable charring of the body at the points of contact of the electrodes, and a minute hæmorrhage was found in the serous membranes and ventricles of the brain. The blood was fluid and dark in longitudinal sinuses, corresponding with the region of contact. The blood was carbonised, and there was a decided change in the consistency and colour of the brain, corresponding with the point of contact. Destructive changes in the blood corpuscles were noted. The consensus of

opinion of the spectators was that execution by means of electricity is a failure, even if properly carried out, but that it was not instantly successful to-day because of the low voltage, or owing to a too short application of the current, or for both reasons. Had the current been maintained for 30 or 45 seconds at the first application, it is believed that there would have been no possible question of a satisfactory result.

Telegrams from New York yesterday read as follows:—"Further particulars regarding the execution by electricity show that signs of dissatisfaction were made by the spectators when on the application of the third current smoke was seen to be curling from Kemmler's back. The warder, therefore, again gave a signal to open the switch, when the culprit's body in the chair was surcharged with four distinct shocks. After this no further movement was observed. Dr. Shrady, the editor of the *Medical Record*, has written a letter, in which he says that nothing has been gained over the ordinary method of execution. Science has triumphed, but the question of the humanity of the act is still an open one. The method requires elaborate preparations, involves the manufacture of new machinery, and, moreover, may endanger the lives of the executioners, and even the spectators. All the morning papers publish articles upon the execution, and the opinion is generally expressed that the law authorising execution by electricity will be repealed by the New York Legislature at an early date. It is also held that the various criminals now waiting execution in the New York gaols should be granted a stay of their sentences until the law has been repealed.

**Trial of an Electrician for Manslaughter.**—At Bristol, on Wednesday, an amateur cyclist, named Henry Askham, electrical engineer, was tried before Mr. Justice Denman, charged with the manslaughter of Thomas Davis, at Pensford Hill, in May last. In defence, it was contended that the prisoner could not be held accountable for Davis moving into the track of the machine. The jury, after retiring, returned a verdict of not guilty, and the Judge, in discharging Askham, suggested that he should do something to help the widow of deceased.

**Electrical Aids to Sport.**—Advertisements have recently been seen in the daily press to show that Mr. Gunn, the famous Nottingham cricketer, made his recent memorable score against the Australians by the aid of a "Harness's electropathic belt." Judging from the comparatively few runs he has since made, we can only conclude that his long innings at "Lord's" robbed that belt of its virtue. At all events, if Mr. Gunn could only refer to some back numbers of the REVIEW we feel sure he would do nothing less than explode.

**Exhibition at Frankfort-on-the-Maine.**—Appended are a few of the rules for the forthcoming exhibition:—The exhibition will last five months; it will be opened on May 15th, 1891, and closed on October 15th, 1891, the committee reserving themselves the right of altering above dates. Only such objects will be admitted to the exhibition which can be brought under the following heads:—Motors for electrotechnical purposes, as steam, water, air or gas motors, with the necessary appliances for producing steam, &c.; production of electricity; transmission of electricity, with all transmitting and supplementary apparatus; accumulating and transforming apparatus; transmission of electric power with a view to industrial purposes; electric light, with special subdivision for fittings of all kinds; telegraphy and telephony; electric signalling, as applied to railways, mines, nautical and military matters and private houses; protection against fire, thieves, and lightning; electro-metallurgy and electrolysis; measuring instruments, scientific apparatus, acoustic and optical instruments relating to electricity, school-teaching apparatus; electricity as applied in medicine and surgery; electrotechnical literature. Mention must be made whether the objects are for sale and at what price, and if

required the words "for sale" must be affixed. Cost of fire insurance to be borne by the exhibitors. Insurance cared for by the committee, the value to be conscientiously given on the schedule of applications. The committee provide working power and main transmissions, as well as the necessary quantity of electricity, steam, water, and gas. Should the exhibition close with a surplus, up to one-half of the same will be applied to a total or partial repayment of expenses incurred for space and power by exhibitors. Exhibitors are bound to insulate all wires for electric currents belonging to their exhibits, and to guard the same in such a way as to exclude all possible danger to the public and the buildings. The laying of cables or setting up of wires can be done by special permission of the committee only and under the supervision of the latter's employees. Whenever the committee should think fit, such cables are to be fixed by their own workpeople at the exhibitor's charge. All applications and communications to be addressed to "An den Vorstand der Elektrotechnischen Ausstellung, Frankfort-on-the-Maine."

**American Patent Office.**—The American Patent Office has recently given an example of its method of work. Two patents issued on the same day read as follows:—"Claim 1, Patent 432,131, dated July 15th, 1890, reads:—1. In a current regulator or rheostat, the combination of a surface of non-conducting material coated with a conducting substance, and in which the conductivity decreases from one place upon the surface to another, means for connecting a conductor with a portion of the conducting material of greatest conducting power, and a movable contact device movable over the contact surface, and formed with a series of flexible fingers resting upon said conducting material. Claim 1, Patent 432,279, dated July 15th, 1890, reads:—1. In a current regulator or rheostat, the combination of a surface of non-conducting material, provided with a coating of conducting substance which gradually decreases in breadth from one point to another, means to connect a conductor with said coating of conducting substance at the point of its greatest breadth, and a contact-piece movable over said conducting surface with a contact face of greater width than the decreasing breadths of the conducting surface, whereby as said contact piece is moved over said conducting surface the area of its contact face in contact with the conducting surface will gradually decrease." We fear Americans beat us in many things; in patents we are miles behind.

#### NEW COMPANY REGISTERED.

**Grange Syndicate, Limited.**—Capital £2,000 in £5 shares. Object: To develop and experiment upon Groth's Electric Tanning System in conjunction with the patentee upon terms of an agreement with Mr. L. A. Groth. Signatories (with 1 share each): L. A. Groth, C.E., 3, Tokenhouse Buildings; T. W. Maule, L.C.C., 12, The Grange, Bermondsey; F. Fleming, Halifax; C. Clark, 20, Great St. Helens; A. Vinos, Sevenoaks; F. Whitcomb, 27, Endsleigh Gardens, N.W.; L. Tucker, Victoria Mansions, Westminster. Registered 1st inst., without special articles, by Courtenay, Croome and Company, 9, Gracechurch Street.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Lancashire and Yorkshire Electric Lighting Company, Limited.**—The annual return of this company made up to the 9th ult. was filed 30th ult. The nominal capital is £100,000 in £5 shares. 127 shares are taken up, and £2 10s. per share has been called thereupon. The calls paid amount to £315 and unpaid to £2 10s.

**Manchester Edison-Swan Company, Limited.**—The annual return of this company made up to the 28th ult. was filed 29th ult. The nominal capital is £550,000 divided into 50,000 "A" shares of £9 each, and 10,000 "B" shares of £10; 20,000 of the former and the whole of the latter are taken up. Upon each "A" share the sum of £1 has been called, and upon each "B" share £10 has been called. The calls paid amount to £20,000 on the "A" shares and £100,000 upon the "B" shares.

**Patent Electric Fire Lighter Company, Limited.**—At an extraordinary general meeting of this company, held at the offices of Messrs. Heath, Parker & Co., 3, New London Street, Mark Lane, on June 23rd, it was resolved to wind up voluntarily, Mr. Wm. Finch being appointed liquidator at a remuneration of £10, with instruction to transfer the business to a new company to be called the New Electric Fire Lighter Company, Limited. The resolution was confirmed on the 10th ult., and duly registered on the 31st ult.

**Key's Electric Company, Limited.**—The statutory return of this company made up to the 24th ult., was filed on the 30th ult. The nominal capital is £15,600 in 3,000 ordinary shares of £5 each, and 600 founders' shares of £1 each, the whole of the ordinary shares and 450 founders' shares are taken up, upon the former 10s. per share has been called, and the full amount upon the latter. The calls paid amount to £1,896, and unpaid upon founders' shares £54. Registered office, 122 and 124, Charing Cross Road.

**New Portable Electric Lamp and Power Syndicate, Limited (in liquidation).**—The registered office of this company is now situate at 43, Coleman Street.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Anglo-American Telegraph Company, Limited.

THE Marquis of Tweeddale presided in the absence of the Chairman, Viscount Monck, at the ordinary general meeting of the shareholders, held at Winchester House, last Friday, and in presenting the report (printed in our last issue), and accounts for the year ending 30th June, 1890, said the increase shown on traffic receipts, viz., £2,025 over the corresponding period of last year was satisfactory, because, in the first place, the period was the least profitable, and, in the second place, because he believed the increase was due mainly to the opening of three new offices in New York, which had brought the company in closer contact with the telegraphing public of that city. The revenue from those offices would no doubt be further increased as they became better known. It was also satisfactory to note that the whole of the company's cables were in good condition. There had been fewer faults to repair, which was in a great measure owing to the Duxbury cable (referred to on previous occasions), so that the expectations formed had been fully realised. Moreover, all the cables of the pool were in equally good order. One of the cables of the Western Union Company, after having been out of order for something like 13 months, was now repaired, at the great depth of some 2,500 fathoms. The company's traffic had been conducted with the usual accuracy and efficiency, and, he was glad to add, at a speed higher than had been achieved by any other Atlantic company. The directors had been, for the last six months, expecting a settlement of the dispute with the Paris and New York Telegraph Company, which had not yet been arrived at, and he had no notion as to what the decision would ultimately be. They observed that the company's working expenses had increased by about £5,692. The increase was almost entirely made up of one figure, viz., £4,352, spent in the establishing the three offices referred to, the balance being composed of a number of small items calling for no particular notice. Expenditure on repairs showed an excess of £2,023; that was really a satisfactory feature, since the repairs had been entirely of a character chargeable to revenue. For renewals, the expenditure had been extremely small, and amounted to £552 19s. 5d. only, consequently the whole of the interest upon the renewal fund had been credited to that fund, making it £968,861 18s. 7d., the market value of which was about £50,000 more; in fact, the renewal fund amounted to over a million. The terms under which the company acquired the Brest-Salcombe cable from the liquidators of the Submarine Telegraph Company were altogether satisfactory. He moved the adoption of the report and accounts, and was seconded by Sir Jas. Anderson.

A Shareholder was sorry that the whole of the interest had been credited to the renewal fund. There ought to be some limit to the extent of that fund.

Another Shareholder reminded the meeting that some time ago it was tacitly agreed that the renewal fund must not exceed one million. He thought that on the next occasion the directors

should abstain from adding interest to that fund, since, with the value of the investments, it already exceeded the limit agreed upon.

Another Shareholder suggested that henceforward the whole of the renewal fund should be appropriated to the deferred shareholders, seeing that it had come entirely out of their pockets. (Cries of dissent.)

The Chairman was aware of the agreement referred to. It was most important the company should have an ample renewal fund. Its cables were growing older, and considerable sums might soon have to be spent for renewals.

The motion to adopt the report and accounts was carried, and the meeting dissolved.

### City and South London Railway Company (late City of London and Southwark Subway Company).

THE report of directors to the shareholders at the twelfth half-yearly ordinary meeting of the company, to be held at Winchester House, next Tuesday, at 12 o'clock noon states:—

During the past half-year both of the tunnels have been completed, the whole of the permanent way laid, and the underground stations finished with the exception of tiling, painting, and other small matters. The surface stations and the lifts are rapidly approaching completion, and the hydraulic pipes and electric conductors are laid throughout. At Stockwell depot the inclined road leading to the tunnels is finished and in use, the two engines and dynamos for the electric power are completed, and the third or reserve engine and dynamo is nearly ready, the three engines in connection with the hydraulic power for working the lifts are also ready, and the engine house and carriage stores are roofed in. A portion of the rolling stock is ready for delivery, and it is expected the railway will be opened for public traffic at an early date.

The Bill for the extension of the line to Clapham has passed through Parliament, and received the Royal assent. By it the name of the company is changed to the "City and South London Railway Company."

The Bill referred to in the last report, and known as the Central London Railway Bill was thrown out in the House of Lords. Your directors will have to consider how far some of the advantages proposed by that Bill could be usefully provided by this company without the objections urged against that measure.

To meet the wishes of many of the larger shareholders notice has been given of a resolution to convert the share capital of the company into stock, so as to facilitate its transfer.

Mr. J. H. Greathead, M.I.C.E., the engineer, reports as follows:—

During the last half-year the remaining length of tunnel through the wet strata at Stockwell has been completed, and the permanent way and hydraulic pipes have been laid throughout both sections of the line.

With the exception of some small matters, such as portions of the glazed tiling and painting, the underground works from the City to Stockwell have been finished, and the buildings on the surface are in a forward state.

The lifts and signalling arrangements are approaching completion.

The engines for generating the hydraulic power, and the boilers for working all the machinery, are ready for starting.

The electric working conductor has been fixed throughout; two of the three electric generating engines have been erected; delivery of the locomotives has commenced, and some of the carriages are ready for delivery.

### The London Road Car Company.

At the half-yearly meeting of the shareholders of the London Road Car Company (Limited), at the City Terminus Hotel, Cannon Street, on Tuesday last, under the presidency of Lieut.-Col. C. F. Colville,

Mr. George Offer in the course of a discussion which ensued upon the Chairman's motion for the adoption of the report said that at a previous meeting he had made allusion to the subject of the progress made with electrical traction. His remarks, however, were met with derisive laughter from some of the shareholders, and one of the directors went so far as to venture into prophesy, telling the meeting that not in their time would they see omnibuses propelled by electricity. Now, he (Mr. Offer) in justice to himself and as a warning to his jubilant friend, Mr. Hodgson, would like to read an account of what had recently taken place showing that in London the electrical omnibus was a fact. Only the other day there was seen in the afternoon coming down St. Martin's Lane, into Trafalgar Square, the first of the new line of the electrical omnibuses, which was driven by Mr. Ward, the managing director. It came down the street with one passenger inside, and two outside, going at a rattling pace, and went in and out the ordinary traffic without difficulty. Mr. Offer said that when he spoke on the subject at the last half-yearly meeting he did so with such a knowledge of the facts that he was able to form an opinion on it. He now said, therefore, that the day would come and at a not very distant period, when all their anxieties about the price of forage, and the health of their horses, would be at an end. He was pleased that the meeting had not that day met his remarks with derisive laughter, and he hoped they would go a step further, and when it came to the time to make an addition to the board of directors, that they would consider the

qualifications of their candidates in the direction of their possession of some knowledge of electrical traction. (Hear, hear, and laughter.)

The Chairman, in briefly replying to Mr. Offor, said that he (the speaker) did not think they need discuss the question of electrical omnibuses. There was no doubt they would keep their eyes open when these 'buses appeared, but until then they were unable to do so.

### The North Metropolitan Tramways Company.

MR. GEORGE RICHARDSON presided on Wednesday at the 41st half-yearly meeting of the North Metropolitan Tramways Company, held at Cannon Street Hotel. The report contained the following paragraphs:—"The Bill introduced into Parliament this year for authorising an increase of the share capital of the company to the extent of £100,000, and also for the use of electricity as a motive power for propelling the cars throughout the system, received the Royal Assent July 4th, 1890. Application has been made to the local authorities for consent to work some of their lines by this power." "The arrangements entered into with the General Electric Power and Traction Company, Limited, referred to in the last report for working the cars on the Barking Road section are in operation, and during the last half-year they have run 44,047 miles."

The Chairman, in moving the adoption of the report, commented briefly on these particulars. He said that the company had lost no time in applying to the London County Council and the West Ham Board for permission to use electricity, they being the two corporations having jurisdiction in the place where the directors proposed to try it. They did not intend to devote any of their money to experiments with electricity. If any person would come forward and make the installation, they would receive all the assistance the company could give, so long as there was no risk of spoiling a good traffic. The line at Barking was working now, and they would see the result later on. It was worked by contract at 4½d. per mile. With regard to the use of electricity elsewhere, in the United States a large number of lines were working by electricity, chiefly on the overhead system. He was not aware whether they could ever have that in this country, as there were difficulties in the way—the streets were narrow, and they would have to contend with the prejudices of the people. There were other systems, but steam was nowhere, as could be seen by a comparison of their dividends with the dividends on the North London Tramways Company.

The report was afterwards adopted.

### The Cuba Submarine Telegraph Company.

THE directors' report and accounts for the half-year ending 30th June, 1889, were laid before the shareholders on their thirty-eighth general meeting, held at the company's offices, 53, Old Broad Street, E.C., on Wednesday last, Mr. Thomas Greenwood presiding.

The Chairman said the half-year had been a period of some little anxiety, but, on the whole, not by any means an unsatisfactory one. It was the second half of the first year of the reduced tariff; therefore, in making the comparison they must bear in mind that it was compared with the period when the rates were 25 per cent. higher. The shareholders would observe that the receipts were £23,671 in June, 1889, and £23,206 in June, 1890, a difference of only £465. Of course a larger number of messages had been carried. It sometimes happened that increased traffic was accompanied by additional working expenditure. That had not been so with the company; in fact, as compared with the previous corresponding half-year, it had saved £30. They might ask how it happened that the dividend was reduced from 9 to 8 per cent. The explanation was that during the last half-year an addition had been made to the undivided balance, whereas in the corresponding period of the previous year that balance underwent a large diminution, which would account for the missing £800. In the future they would compare what was fairly comparable—viz., the reduced rates in 1890-91 with the reduced rates in 1889-90. He was pleased to say that the receipts for July, the first month of the new half year, showed a comparative increase of nearly £150, which, if it continued, would mean an improvement for the whole year of some £900, or more than sufficient to make a dividend of 1 per cent. Provided the company was not interfered with by outside influences, there was no reason for supposing that its dividend would be further reduced. They were aware that a proposal was before the Spanish Government involving the making of another cable, *via* the North Coast, which, if made, must inevitably attract to it a large portion of the company's traffic, and, at the same time, the Spanish Government had made a representation to the various telegraphic companies located in the Spanish colonies with a view to still further reducing the rates. Having already made a large abatement, it seemed a little unfair, especially as the Spanish Government was consenting to the extension of a rival company's line almost parallel with theirs. He need scarcely say the board was not prepared to consent to any abatement so long as they were threatened with the new line, and so long as the abatement was not a general one. To return to the accounts, a comparatively small addition had been made to the reserve fund, owing to so much money having been spent on the company's cables; but they might console themselves with thinking that the repairs to the cables made a large addition to the reserve unnecessary. The expenditure on repairs had been larger

than in any previous half-year; they had now a complete duplicate system between Cienfuego and Santiago, and with the projected new cable between Batabano and Cienfuego, their system would be complete and in duplicate from end to end. Progress had been made with the new cable, and they might reasonably expect to hear of its completion before their next meeting. He moved the adoption of the report and accounts, and, in reply to a shareholder, explained that the steps the directors had ultimately thought fit to take legal action, with a view to setting aside the concession above referred to.

The motion was carried.

The Chairman next moved to declare dividends of 10 per cent. per annum, subject to income-tax, on the preference shares, and 8 per cent., free of tax, on the ordinary shares of the company, payable on and after the 7th inst.

The motion was carried unanimously. Mr. Alexander F. Low was re-elected a director, and Mr. John Gane reappointed auditor, and, with a vote of thanks to the board, the proceedings terminated.

### The Maxim-Weston Electric Company, Limited.

The shareholders, at an extraordinary general meeting held yesterday, after hearing a statement of the company's affairs during the past six months from Mr. Gooding, the chairman, have resolved to wind up the company voluntarily and have appointed Messrs. Marks and Hodgson liquidators. It seems the company started with a nominal capital of £40,000 or £50,000, of which only £14,000 was subscribed. The private meeting held a few weeks since to ascertain the feeling of the shareholders with regard to subscribing more money, resulted in the promise of some £1,500 by way of debentures, a sum not nearly sufficient in the directors' opinion, to carry on the concern. The company is just able to discharge its liabilities amounting to about £300. The plant at the works is estimated at £7,000 as a going concern. Under the circumstances it was natural to suggest a reconstruction and this was done by Mr. Marks, who observed that there was still a gigantic field of work open to the company in the way of lighting. The proposal, however, found no favour with the meeting. A full report of the meeting will appear in our next issue.

### The Berlin General Electricity Company.

The general meeting of the shareholders in the above company has just approved the increase of the share capital from 16,000,000 to 20,000,000 marks. The new shares are offered to the old shareholders at the price of 165 per cent. The issue has been guaranteed by a syndicate of bankers, who are to receive 5 per cent. for their guarantee. This increase of capital has been necessitated by the increasing extent of the company's business, it having now undertaken the working of the Halle Metropolitan Electric Railway, besides having concluded contracts with two other towns for the establishment of electric railways.

### Elmore's Patent Copper Depositing Company.

The *Financial Times*, of August 5th, devotes a long criticism to the company, which has now been in existence for more than 18 months, and yet, according to our contemporary, has done no genuine work. The earnings of the company from its factory seem to be absolutely non-existent. It is hardly possible to suppose, says the financial paper, that even the "docile race" of shareholders will take up another issue of wire shares at a premium, when they learn that the vendors only value their patents at less than one-fifth of the price charged for them.

**The Western Counties and South Wales Telephone Company, Limited.** whose head offices are at 16, High Street, Bristol, have posted dividend warrants for an interim dividend for the half-year ending 30th June last, on the preference shares of the company, at the rate of 6 per cent. per annum.

**The Pilsen, Joel and General Electric Light Company, Limited.**—A general meeting of the company will be held at the office of the liquidator, Mr. George Shead, 18, Laurence Pountney Hill, Cannon Street, E.C., the 5th September, 1890, at 11, when the liquidator's accounts, &c., will be produced.

**The Byng Telephone Company, Limited.**—It has been resolved to wind up the company voluntarily; Mr. John Philip Spencer, 48, Cullingwood Street, Newcastle-on-Tyne, is the liquidator.

### TRAFFIC RECEIPTS.

- The Cuba Submarine Telegraph Company, Limited. The receipts for the month of July were £1,150, as compared with £3,093 in the corresponding month of last year. The receipts for the month of April, estimated at £3,500, realised £3,624.
- The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of July were £3,016, against £1,677 in the corresponding period of last year.
- The Great Northern Telegraph Company, Limited. The receipts for the month of July amounted to £25,000; 1st January—31st July, 1890, £156,000; corresponding months 1889, £164,200; do. 1888, £156,000.
- The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 1st, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,921.
- The West Coast of America Telegraph Company, Limited. The gross earnings for the month of July, 1890, were £5,825.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 31).	Closing Quotation. (August 7.)	Business done during week ending August 7, 1890.	
					Highst.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	97 — 100	98½	...
1,549,160	Anglo-American Telegraph, Limited	Stock	49½ — 50½	49½ — 50½xd	50	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	85 — 86 xd	85 — 86 xd	86	85½
2,725,420	Do. do. Deferred	Stock	13½ — 14½xd	13½ — 14	14½	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12	11½ — 12	18½	...
99,000	Do. do. 5 p. c. Bonds...	100	102 — 104	100 — 102 xd	...	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416...	3	1½ — 2	1½ — 2	1½	...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 1½	1½ — 2	1½	...
\$7,216,000	Commercial Cable, Capital Stock	\$100	103 — 105	103 — 105	103½	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	9 — 10	9 — 10	...	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½xd	5½ — 5½xd	...	...
16,000	Cuba Telegraph, Limited	10	12½ — 13½	12½ — 13½	12½	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	17½	17½
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4	3½ — 4	...	...
6,090	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9½	...
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½xd	10½ — 10½xd	10½	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½xd	13½ — 14½xd	14½	13½
70,000	Do. do. 6 p. c. Preference	10	15 — 15½xd	15 — 15½xd	15½	15½
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	108 — 111	106 — 109 xd	...	...
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½	14 — 14½	14½	14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	101 — 103	100 — 102 xd	...	...
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106	103 — 106	103	...
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	103 — 106	...	...
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 — 103	100 — 103	101½	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½	...	...
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	4 — 4½xd	4½ — 4½xd	4½	4½
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	5	2 — 2½	2 — 2½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	8½ — 9½	9½	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15½	14½ — 15½	14½	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	16½	15½
40,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103	100 — 103	...	...
250,000	Do. do. (issue of 1883)	100	106 — 109	106 — 109	...	...
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	12 — 13	12 — 13	...	...
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½	...	...
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18½ — 19½	...	...
200,000	Do. do. 4½ p. c. Deb., 1896...	100	102 — 104	102 — 104	...	...
17,000	Indo-European Telegraph, Limited	25	37 — 39	37 — 39	38½	38
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000	Do. do. 6 p. c. Debentures	100	107 — 110	107 — 110	...	...
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000...	10	4 — 4½	4 — 4½	...	...
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4½ — 5	4½ — 5	5	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 12½	12½ — 12½	12½	...
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	10½	10½
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	4 — 4½	4 — 4½	...	...
9,000	Reuter's, Limited	8	7½ — 8½	7½ — 8½	...	...
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	4 — 4½xd	4 — 4½xd	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3 xd	2½ — 3 xd	...	...
3,381	Submarine Cables Trust	Cert.	112 — 116	113 — 117	...	...
78,949	Swan United Electric Light, Limited	5	5 — 5½	5 — 5½	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	42
150,000	Do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	...	...
55,000	United River Plate Telephone, Limited	5	4 — 4½xd	4 — 4½xd	...	...
146,000	Do. do. 5 p. c. Debenture Stock...	Stock	90 — 9½	90 — 9½	...	...
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10	...	...
300,000	Do. do. 5 p. c. Debentures	100	100 — 103	100 — 103	101½	100½
30,000	West Coast of America Telegraph, Limited	10	5 — 6 xd	5 — 6 xd	5½	...
150,000	Do. do. 8 p. c. Debs, repay. 1902	100	106 — 110	106 — 110	...	...
64,572	Western and Brazilian Telegraph, Limited	15	10 — 10½	10 — 10½	10½	10
26,986	Do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 7	...	...
26,986	Do. do. 5 p. c. Deferred	7½	3½ — 4½	3½ — 4½	4	...
200,000	Do. do. 6 p. c. Debentures "A," 1910...	100	106 — 109	103 — 106 xd	104½	103½
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	104 — 107	101 — 104 xd	...	...
88,321	West India and Panama Telegraph, Limited	10	2½ — 2½	2½ — 3	2½	2½
34,563	Do. do. 6 p. c. 1st Preference	10	11 — 11½	11½ — 11½	11½	...
4,669	Do. do. 6 p. c. 2nd Preference	10	12½ — 13½	12½ — 13½	...	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125	...	...
179,800	Do. do. 6 p. c. Sterling Bonds	100	99 — 101	99 — 101	...	...
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 1½	1½ — 1½	...	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Electric Construction Corporation (£10 paid), 7½—8½  
 Elmore Copper Depositing Priorities, 5½—6½.—Elmore Wire, 4 dis—par.—House-to-House Company (£5 paid), 5 — 5½.—London  
 Electric Supply Corporation, Ordinary (£5 paid), 1½—2.—Manchester Edison and Swan Company, £9, (£1 paid), 12/-—14/-.

MAGNETIC PROPERTIES OF ALLOYS OF  
NICKEL AND IRON.\*

By J. HOPKINSON, D.Sc., F.R.S.

Eight different alloys have been examined. The methods of experiment were the same as were detailed in my paper on "Magnetic and other Physical Properties of Iron at a High Temperature." The dimensions of the samples were also the same.

A. The following is the analysis of this sample:—

Fe.	Ni.	C.	Mn.	S.	P.
97.96	0.97	0.42	0.58	0.03	0.04 per cent.

In this case a magnetisation curve is all that I have obtained free from doubt; the sample was heated and its magnetisation determined at various temperatures for a force of 0.50, but the higher temperatures must be taken as a shade doubtful, as the secondary broke down before cooling, and I cannot be sure whether or not the resistance of the secondary may have changed.

Table I gives the results at the ordinary temperature for the material before heating.

TABLE I.

Magnetising force.	Induction.
0.06 ... ..	11
0.12 ... ..	29
0.26 ... ..	58
0.53 ... ..	122
1.07 ... ..	303
2.14 ... ..	995
4.7 ... ..	4,560
8.8 ... ..	9,151
16.8 ... ..	12,876
38.9 ... ..	15,651
270.0 ... ..	21,645

The only noteworthy features are that the coercive force is obviously somewhat considerable, and that the maximum induction is great—greater than that of the more nearly pure iron.

B. The following is the analysis of the sample:—

Fe.	Ni.	C.	Mn.	S.	P.	Si.
94.799	4.7	0.22	0.23	0.014	0.037	trace per cent.

We have here results of induction in terms of temperature for a magnetising force of 0.12. The experiment with rising temperature was made by simply observing with a watch the hour at which the temperature attained successive values whilst the piece was in the furnace; the cooling experiments were made in exactly the way described in "Phil. Trans." A, 1889, p. 463.

The most remarkable feature in this case is that the material has two critical temperatures, one at which it ceases to be magnetisable with increase of temperature, the other, and lower, at which it again becomes magnetisable as the temperatures fall, and that these temperatures differ by about 150° C. Between these temperatures, then, the material can exist in either of two states—a magnetisable and a non-magnetisable.

We may infer from the experiments that the latent heat liberated in cooling is about 150 times the heat liberated when the temperature of the material falls 1° C.

C. This alloy is very similar to the last; its analysis is:—

Fe.	Ni.	C.	Mn.	S.	P.
94.39	4.7	0.27	0.57	0.03	0.04 per cent.

In Table II. are given the results of observations of induction in terms of magnetising force at the ordinary temperature of the room.

TABLE II.

Magnetising Force.	Induction.
0.06 ... ..	14
0.12 ... ..	29
0.25 ... ..	60
0.52 ... ..	127
1.05 ... ..	294
2.10 ... ..	760
4.6 ... ..	3,068
8.7 ... ..	8,786
16.6 ... ..	13,641
38.5 ... ..	16,702
266.5 ... ..	21,697

D. This sample contains 22 per cent. of nickel. It was not thoroughly tested, as the supply of CO<sub>2</sub> which happened to be available was insufficient. Its magnetic properties, however, were similar to the next sample.

E. The analysis of this sample was—

Fe.	Ni.	C.	Mn.	S.	P.	Si.
74.31	24.5	0.27	0.85	0.01	0.04	0.02 per cent.

As the material was given to me it was non-magnetisable at ordinary temperature; that is to say, the permeability was small, about 1.4, and the induction was precisely proportional to the magnetising force. The ring on being heated remained non-magnetisable up to 700° C. or 800° C. A block of the material did

not recalesce on being heated to a high temperature and being allowed to cool.

On being placed in a freezing mixture, the material became magnetic at a temperature a little below freezing point.

The material was next cooled to a temperature of about -51° C. by means of solid carbonic acid. After the temperature had returned to 13° C. the curve of magnetisation was ascertained; from this it appeared that the ring of the material which was previously non-magnetisable at 13° C. was now decidedly magnetisable at the same temperature. On heating the material it remained magnetisable until it reached a temperature of 580° C. At this temperature it became non-magnetisable, and, on cooling, remained non-magnetisable at the ordinary temperature of the room. The experiments showed that through a range of temperature from somewhat below freezing to 580° C. this material exists in two states, either being quite stable, the one being non-magnetisable, the other magnetisable. It changes from non-magnetisable to magnetisable if the temperature be reduced a little below freezing; the magnetisable state of the material does not change from magnetisable to non-magnetisable until the temperature is raised to 580° C.

The same kind of thing can be seen in a much less degree with ordinary steel. Over a small range this can exist in two states; but in changing its state from non-magnetisable to magnetisable a considerable amount of heat is liberated, which causes rise of temperature in the steel. It is observed in samples B and C of nickel steel, but at a higher temperature.

As might be expected, the other physical properties of this material change with its magnetic properties.

The wire as sent to me was magnetisable as tested by means of a magnet in the ordinary way. On heating it to a dull redness it became non-magnetisable, whether it was cooled slowly or exceedingly rapidly, by plunging it into cold water. A quantity of the wire was brought into the non-magnetisable state by heating it and allowing it to cool. The electric resistance of a portion of this wire, about 5 metres in length, was ascertained in terms of the temperature; it was first of all tried at the ordinary temperature, and then at temperatures up to 340° C. The wire was then cooled by means of solid carbonic acid. The wire was then allowed to return to the temperature of the room, and was subsequently heated; the heating was continued to a temperature of 680° C., and the metal was then allowed to cool. From this it appeared that in the two states of the metal (magnetisable and non-magnetisable) the resistances at ordinary temperatures are quite different. The specific resistance in the magnetisable condition is about 0.000052; in the non-magnetisable condition it is about 0.000072. The curve of resistance in terms of the temperature of the material in the magnetisable condition has a close resemblance to that of soft iron, excepting that the coefficient of variation is much smaller, as, indeed, one would expect in the case of an alloy; at 20° C. the coefficient is about 0.00132; just below 600° C. it is about 0.0040, and above 600° C. it has fallen to a value less than that which it had at 20° C. The change in electrical resistance effected by cooling is almost as remarkable as the change in the magnetic properties.

Samples of the wire were next tested in Prof. Kennedy's laboratory for mechanical strength. Five samples of the wire were taken which had been heated and were in the non-magnetisable state, and five which had been cooled and were in the magnetisable state. There was a marked difference in the hardness of these two samples; the non-magnetisable was extremely soft, and the magnetisable tolerably hard. Of the five non-magnetisable samples, the highest breaking stress was 50.52 tons per square inch, the lowest 48.75; the greatest extension was 33 per cent., the lowest 30 per cent. Of the magnetisable samples, the highest breaking stress was 88.12 tons per square inch, the lowest 85.76; the highest extension was 8.33, the lowest 6.70. The broken fragments, both of the wire which had originally been magnetisable and that which had been non-magnetisable, were now found to be magnetisable. If this material could be produced at a lower cost, these facts would have a very important bearing. As a mild steel, the non-magnetisable material is very fine, having so high a breaking stress for so great an elongation at rupture. Suppose it were used for any purpose for which a mild steel is suitable on account of this considerable elongation at rupture, if exposed to a sharp frost its properties would be completely changed—it would become essentially a hard steel, and it would remain a hard steel until it had actually been heated to a temperature of 600° C.

F. This sample contains 30 per cent. of nickel.

The remarkable feature in this case is the low temperature at which the change between magnetisable and non-magnetisable occurs, whether the temperature is rising or falling. Comparing it with the last sample, the character of the material with regard to magnetism is entirely changed.

G. The analysis of this sample is:—

Fe.	Ni.	C.	Mn.	S.	P.
66.19	33.0	0.28	0.50	0.01	0.02 per cent.

The remarkable feature of this material is the complete difference from the last but one, and the low temperature of change. There is but very little difference between the temperature of change when heated and when cooled.

H. The analysis of this sample is:—

Fe.	Ni.	C.	Mn.	S.	P.
26.50	73.0	0.18	0.30	0.01	0.01 per cent.

It is curious to remark that with this material the induction for considerable forces is greater than in the steel with 33 per cent. of nickel; and that it is greater than for a mechanical mixture of

\* Abstract from Proceedings of the Royal Society.

iron and nickel in the proportions of the analysis, however the particles might be arranged in relation to each other.

The critical temperature of the material is 600° C.; it shows no material difference between the critical temperatures for increasing and diminishing temperatures.

LIFE AND EFFICIENCY OF ARC LIGHT CARBONS.\*

SINCE the earlier stages of arc lighting little or no increase in the efficiency of the carbon points appears to have been made. Now that the dynamo machines and lamps have reached such a state of perfection, the subject presents itself as pre-eminently important. The arc light pencil, considered as an individual part of the system, is indeed a small thing, but in it undoubtedly lies the weak spot of the system. With a view of studying the action of modern carbon pencils, the investigations herein described were undertaken. The carbons experimented upon were all of American manufacture, and were procured from five companies (A, B, C, D, E).

While the greater part of the research was upon the life and efficiency of the pencils, observations were also made in other directions.

The subject was treated under the following heads:—

- 1. Structure of the carbons.
- 2. Life tests.
- 3. Efficiencies.
- 4. Candle-power measurements.
- 5. Observations of the arc and carbon points.

1.—STRUCTURE OF THE CARBONS.

It is well known that the life and efficiency of a carbon depends upon the system in which the carbon is burned. For instance, the requirements of the low tension system seems to be a carbon that is hard, well plated and a good conductor, the latter being the most important. In the high tension system, on the contrary, hardness and conductivity seem to be of secondary importance. There is a tendency to "flame" and burn unsteadily when a hard carbon is used in this system, and a softer one sometimes becomes necessary.

It is interesting to note the methods employed by carbon manufacturers to attain the conditions above mentioned. In one of the largest carbon works, "forced" carbons, or those made by "squirting" the plastic material through a die, are manufactured for both high and low tension systems of lighting, to the exclusion of moulded pencils. On the other hand, another company makes no forced carbons, but claims that its moulded carbons are superior for either system. The classification given below shows the types of carbons now upon the markets for both systems.

Thin transverse sections of all the specimens were cut and mounted on glass slides, and a microscopical examination made.

Carbon.	High ten-sion.	Low tension.
A	(1) moulded	(2) forced
B	(3) "	(4) moulded
C	(5) "	(6) "
D	(7), (8) forced	(8), (9) forced
E	{ (10) moulded } { (11) forced }	(12) "

On examination a marked difference is seen between the structure of a moulded and a forced carbon. In the high tension pencil (1) the structure is a loose one, while the low tension rod (2) is marked by a dense and homogeneous structure; the size of the grains of carbon in the latter case is much less than in the former, and the particles have a more metalloid lustre. There is probably considerable air space in (1). The two rods thus have respectively the qualifications stated above required for high and low tension pencils. The resistance of (1) was found to be 199 ohm; (2) 144 ohm; while (2) plated was 084 ohm.

In class B, (3) and (4) were of similar structure, and the resistance was varied by the thickness of the copper plating.

In class C (5) and (6), both moulded carbons, the structure varies owing to a far higher pressure being employed in moulding the low tension rods.

In group D, besides a difference in pressure during manufacture, there is also a difference in the "mix" or composition of the carbon; (8) is an attempt to construct a carbon suitable for either high or low tension and is a mean between (7) and (9).

In group E, there is great dissimilarity between (10) and (11) although used for the same purpose; (11) being very similar in structure to (9) D, but containing less pure carbon. The efficiency of these types will be discussed further on.

2.—LIFE TESTS.

If a carbon is burned with a small current its life will be long, at a sacrifice of light-giving properties. If, on the other hand, a

\* Abstract of paper read by Louis B. Marks before the American Institute of Electrical Engineers, Boston.

large current is used, there may be a gain in efficiency at a sacrifice of life. The question arises—what is the proper current to use. Of course circumstances determine to a large extent the answer, and generally such a current is used as gives a fair mortality at a reasonable efficiency of the carbon.

The high tension carbons submitted for test were designed to be burned at about 10 ampères, and the low tension at about 20 ampères. In the life tests a Thomson lamp was used for the high tension runs, current being constantly kept at 10 ampères and P.D. at 50 volts. For low tension carbons a Weston lamp was used. The pencils were accurately weighed before and after the runs, and the life calculated on the assumption that the carbons were homogeneous. Each set of pencils were burned an hour. It has been stated that "with carbons of the same hardness and length, but having different diameters, the larger will undoubtedly outlive the smaller. Of carbons of the same diameter and length, but differing in hardness, the harder will outlive the softer." This statement presupposes that the conductivity of the carbon is directly dependent on the hardness or softness of the pencil. In order to examine more fully the relation between diameter, resistance and mortality of a pencil, six sets of carbons of the brand B, varying in diameter from  $\frac{1}{8}$  to  $1\frac{1}{8}$  inches were carefully weighed, their resistances measured by the Wheatstone bridge method, and the pencils burned with a constant current of 10 ampères, the P.D. at the terminals of the lamp being kept at 50 volts. The diameters and resistances respectively of the upper and lower carbons were in each case practically the same. A mean of 10 micrometer measurements of the diameter was taken as correct. The duration of each run was 60 minutes.

From the results obtained it appears that the life of a carbon varies directly with its diameter and inversely with its resistance. This law holds good only for homogeneous carbons of the same manufacture, type, and structure, and as stated previously, for constant current and voltage.

Taking the  $\frac{1}{8}$  inch (.505 inch) and 1 inch (.986 inch) pencils as standards and from the relation above stated, calculate the mortality of the other carbons.

The table gives a comparison between the actual and the calculated life of the specimens tested.

TABLE.				
Carbon.	Mean diameter in inches.	Standard $\frac{1}{8}$ inch (.505)	Standard 1 inch.	Actual life hours.
		Calculated life hours.	Calculated life hours.	
B moulded light	.453	10.92	9.32	10.64
" "	.618	15.10	13.62	13.64
" "	.739	21.58	19.44	21.38
" "	1.195	36.40	33.04	33.49

Thus it appears that the calculated life is larger than the actual when the half-inch carbon is taken as a standard, and smaller when the 1 inch pencil is made the basis of calculation. Every precaution is taken to avoid discrepancies, but errors are apt to creep into the work. The results, however, without doubt, point to the existence of such a law as has been quoted.

Next, experiments were made to determine the curve for current and mortality of the pencil, when the voltage is kept constant. The range of current was from 6 to 13 ampères, and greatest variation in tension was one volt.

Another series of tests was made with constant currents and varying voltage. The current being kept at 10 ampères, and the range in tension was from 40 to 60 volts. In these tests the consumption of carbon was taken for both pencils + and -.

Very little has been published relative to the life of the plus and minus carbons; Munro and Jamieson state that, "with continuous currents the plus wastes twice as fast as the minus carbons. With alternating currents the upper wastes 8 per cent. faster than the lower if the carbons are vertical, but at the same rate if horizontal." The accompanying table shows the result of our tests on this point.

TABLE.—RELATIVE LIFE OF THE PLUS AND MINUS CARBONS

Carbon.	Current in amperes.	E.M.F. volts.	Time of run in mins.	Loss + grms.	Loss - grms.	Life $\frac{1 \text{ in.}}{1 \text{ in.}}$ +
B moulded high ten.	10	50	60	5.28	4.40	1.20
B " low ten.	10	50	60	5.14	3.27	1.57
A " high ten.	10	50	60	5.98	3.20	1.87
E forced low ten.	22 $\frac{1}{2}$	28	150	193.18	74.42	2.59
B molded low ten.	22 $\frac{1}{2}$	28	150	166.60	51.50	3.23
C " " "	22 $\frac{1}{2}$	28	145	151.00	41.00	3.68

From this table it can be seen that the + and - carbons may burn away fairly in equal proportions, or may waste in the plus carbon more than three and a half times as quickly as the minus carbon.

For determining the influence of diameter and resistance upon the relative life of the plus and minus carbons, a number of

moulded high tension carbons, A brand, were used, taken from the same batch, and burned with a current of 10 amperes and a voltage of 50. The experiments seem to show that  $\left\{ \frac{\text{life} -}{\text{life} +} \right\}$  appears to become greater with increase of diameter of carbon; but probably the inequality in the diameters of the + and - pencils respectively, as well as the difference of resistance of the two carbons of a set, explains the increase in the ratio. For assuming that under the conditions the life of a carbon varies directly with its diameter and inversely as its resistance, this is an indication that if the diameters and resistances respectively of the + and - carbons were the same in each run, the ratio would be practically the same for all sizes of carbons.

The experiment with change of current and constant potential shows that the change of current, other things being constant, produces very little effect on the ratio  $\left\{ \frac{\text{life} -}{\text{life} +} \right\}$ .

On the other hand, when potential differs and current is constant, the higher the potential the nearer the approach to unity is obtained in the ratio.

The relative life of carbons of the same diameter is influenced chiefly by the difference in the resistance of the carbons and the variations of the P.D.

It was conjectured that blowing the arc during a run with a magnet would increase the life of the + carbon; the reverse was found to be the case, but with little effect on the - carbon.

#### EFFICIENCY.

Two methods of determining the efficiency of each set of pencils were employed. The first was the method used by Mr. Merritt in obtaining the efficiency of the incandescent lamp, and subsequently by Mr. Nakano in his work on the efficiency of the arc lamp. By this method the deflection of a galvanometer was taken as a measure of the energy of the total radiation falling upon the face of a thermopile, the dark leads being cut off by passing the rays through an alum cell. The second method dealt with candle-powers obtained by photometric measurements. Mechanism was employed whereby the angle of radiation from the arc could be altered without altering the distance of the centre of the arc from the thermopile. In the results it was noticed that the horizontal efficiency is very small compared with the maximum; that relatively high efficiency in a forced high tension carbon is obtained only at the expense of life; that a moulded carbon is, generally speaking, superior to a forced for high tension and vice versa for low tension. In the case of the high tension carbons of brand B and D, of smaller diameter than that of the other pencils, we have a relatively higher efficiency, it was shown last year that the efficiency varies inversely as the diameter. A copper-plated carbon lasts longer than a naked one, but the mean sphericity appears to be the same for both, or but very slightly in favour of the coated carbon. The use of the plating prevents disintegration, and so prolongs the life of the pencil; the actual amount of combustion is apparently the same in either case.

The conclusions drawn from the series of candle-power tests show that the efficiency of low tension carbons, and especially of

Spherical C.P. =  $\frac{1}{2}$  horizontal C.P. +  $\frac{1}{2}$  maximum C.P. The average error is only about 5 per cent., and is most generally correct as an approximation. For the total radiation where the efficiency depends upon the ratio  $\left\{ \frac{\text{luminous radiation}}{\text{total radiation}} \right\}$  Gérard's law does not hold, but for approximations spherical efficiency =  $\frac{1}{2}$  horizontal +  $\frac{1}{2}$  maximum.

#### OBSERVATIONS OF THE ARC AND THE CARBON POINTS.

With a given potential difference between the terminals of the lamp, the length of the arc depends upon the current flowing, and increased as the current becomes greater. If the current be constant, the length of arc increases with the P.D. Examining the carbons after burning at varying currents and constant P.D., it was seen that with 5 amperes there was a tendency to form a "mushroom" on the lower or negative carbon; the latter is eaten away considerably just below the tip. With 10 amperes it is less, and at 15 amperes hardly perceptible. The plus carbon has a variable diameter of crater, increasing with the strength of the current, but with a greater depth with the lower currents. With high currents the carbon is disintegrated to a greater distance above the points than with low. With constant current and increasing potential, the shape of the carbons change from a point at 40 volts to a blunt end at 60 volts. The mushroom that forms where the carbon is burned with low current and high voltage, is absent at high current and low voltage. At 60 volts the crater had disappeared, and the carbons flamed; below a certain voltage for every make of carbon there is a point when hissing commences.

At too high a voltage the crater breaks away and flaming begins. Soft cored carbons somewhat remedy this defect and should not flame at all at the proper voltage for the particular make. The breaking off of the small mushroom button on the negative carbons is invariably accompanied by hissing.

The remedy for irregularities in the burning of arc lamps lies with the carbon manufacturer.

In the present state of the art of carbon manufacture, a careful discrimination in selecting carbons should be urged on all central station managers; as recently a comparative test of the best known carbons in the market carried out by Mr. G. F. Peck, of Brooklyn, resulted in a saving of 64.73 electrical horse-power in a station burning a thousand lamps.

## PROCEEDINGS OF SOCIETIES.

### The Institution of Electrical Engineers.

"The Working Efficiency of Secondary Cells." By W. E. AYRTON; C. G. LAMB, E. W. SMITH and M. W. WOODS, Associates. Read at Edinburgh, Wednesday, July 16th.

(Concluded from page 140.)

These two conditions, however, we have fulfilled by the employment of the following device, by means of which the difference between the values of  $v$  and of  $\epsilon$  was measured to the one-thousandth

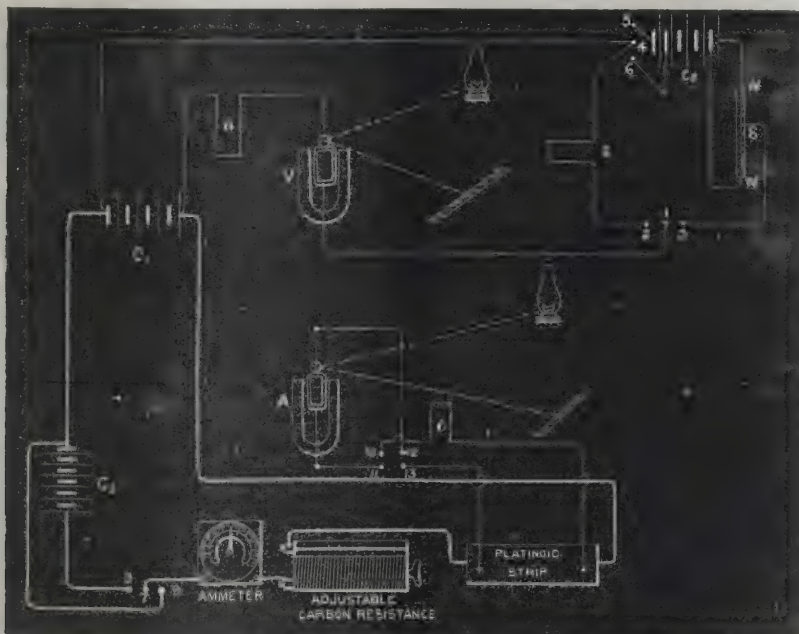


FIG. 10.—APPARATUS FOR MEASURING THE RESISTANCE OF THE ACCUMULATORS  $C_1$ .

moulded low tension carbons, is comparatively small; while the efficiencies of moulded high tension carbons are as high as 783 to 840 candles per electric horse-power expended in the lamp; low tension pencils of the same diameter nearly give only 594 to 502 candles per electric horse-power.

M. Gérard's formula, for the mean spherical candle-power of a lamp, is of sufficient exactitude for practical purpose.

of a volt at identically the same moment that the values of  $v$  and  $\epsilon$  were measured. The process was as follows:—

1. The sensibility of the voltmeter was adjusted so that 12 volts produced a deflection of 600 divisions, and  $v$ , the P.D. at the terminals of the four accumulators under test, was measured.

2. A compensating E.M.F. was introduced into the circuit just sufficient to bring the spot of light to zero.

3. The sensibility of the voltmeter was increased 60 times.

4. The main circuit was broken, and the time variation of  $\epsilon$ , the E.M.F. of the accumulators under test, observed by noting the position of the spot of light at the successive ticks of a metronome, whose rate of going was before each experiment carefully adjusted by comparing the metronome with a chronometer.

5. A time curve for the values of  $\epsilon$  was drawn, and by producing it back until it cut the line passing through time nought—that is, the time when the main circuit was broken—we obtained the value of  $\epsilon$  at the same moment that the values of  $v$  and  $a$  were measured.

The apparatus employed is symbolically shown in fig. 10.  $c_1$  are the four accumulators under test; when they were being charged by means of the accumulators  $c_2$ , a bridge-piece was placed so as to join the mercury cups 7 and 8; whereas, when  $c_1$  were being discharged, mercury cup 7 was joined to 9 instead of to 8. In both cases the current passing along the thick lines through an A. and P. magnifying spring ammeter, whose indications furnished an approximate measure of the current, through an adjustable carbon resistance and a platinoid strip which could carry the maximum current, 10 amperes, used in these tests, without its resistance being perceptibly altered. To two points of this strip were soldered two wires going to the mercury cups 10 and 13; these were joined respectively to 11 and 12 in charging, and to 12 and 11 in discharging, so that the current always went through the D'Arsonval galvanometer, A, in the same direction. This galvanometer then measured the charging or discharging current, its sensibility being such that for a current of 9 amperes passing through the circuit a deflection of 600 scale divisions was produced when the resistance in  $d$  was 185 ohms, that of the galvanometer A itself being 52 ohms.

By joining the mercury cups 1 and 2 with a bridge-piece, the P.D. between the terminals of the accumulators under test,  $c_1$ , could be measured with the voltmeter,  $v$ ; the sensibility being such that with a resistance of 791 ohms in  $a$ , and 63,696 ohms in  $b$ , a deflection of 600 scale divisions corresponded with a P.D. of 12 volts. By connecting the mercury cup 1 with 3 instead of with 2, the resistance,  $b$ , was cut out of the circuit, and the sensibility of the voltmeter,  $v$ , was increased 60 times. If now 4 were connected with 5 or with 6, and the sliding contact,  $s$ , moved along the thick wire,  $w$ , a point could be found such that no current passed through the voltmeter,  $v$ . Next, the main circuit indicated by the thick wires was broken, when the spot of light would move quickly across a portion of the scale, and then continue moving right across the rest of the scale. The first part of this motion was of course due to the sudden variation of the P.D. at the terminals of the accumulators,  $c_1$ , on the current through them being stopped, while the continuation of the motion was due to the subsequent variation of the E.M.F. of these accumulators after the current was stopped. And the value of the E.M.F. at any moment was equal to

$$v \pm \frac{0.2 d}{600},$$

where  $d$  was the deflection of the voltmeter spot of light at the moment in question, and  $v$  was the P.D. between the terminals of the cells,  $c_1$ , just before the main circuit was broken, and which was measured by the voltmeter deflection when mercury cup 1 was connected with 2. In discharging the + sign was, of course, used, and in charging the - sign.

This P.D. at the terminals of the four accumulators under test,  $c_1$ , and which had to be balanced by the E.M.F. of the accumulators,  $c_2$ , approached 9.6 volts towards the end of a charge, while it fell to 7.6 volts at the end of a discharge. In the former case the E.M.F. of four cells and a portion of the fifth of the compensating accumulators,  $c_2$ , was employed, while in the latter the E.M.F. of three and a portion of the fourth sufficed. Hence, during the charge mercury cups 4 and 5 were connected together, while during the discharge it was 4 and 6 that were connected together. The portion of the E.M.F. of the last of the compensating cells was, as shown in the figure, obtained by shunting this cell through a platinoid wire,  $w$ , of about 2 ohms resistance, and making contact with a point of this wire farther from, or nearer to, the positive pole of this cell. This adjustment of the position of  $s$  caused very little change in the resistance of the voltmeter circuit, because the resistance of  $w$ , was but a small portion of the entire resistance in the voltmeter circuit.

This method of measuring the resistance of accumulators was applied by three of the students of the Central Institution—Messrs. Müller, Stephens, and Wightman—to determine the variation of the resistance during the entire discharge of the cells with 10 amperes, and charge with 9; further, during May and June of this year Mr. Müller has, with great perseverance, been making an uninterrupted series of observations, day and night, to determine the resistance during the entire discharge and charge for various currents. For each of these currents the cells are being brought to a steady working state by many discharges and charges being successively and without interruption made with each current. In the case of the small current the time of a charge and discharge is tediously long, the charge, for example, with 3 amperes requiring 40 hours to raise the P.D. from 1.9 to 2.4 volts per cell, so that several weeks have to be spent obtaining the resistance for this current. This investigation of resistance is not yet completed, and therefore we do not propose in this paper to refer to the variation of the resistance of a cell with different currents when the cell is brought to a steady working state for each current. Such an experiment has not, as far as we are aware, ever before been attempted with accumulators

former observers having contented themselves with merely observing the variation of the resistance when the current during discharge or charge was abruptly changed from one value to another. This is a very different thing from ascertaining how the resistance of an accumulator varies with the current when each of the different currents employed is steadily used for some weeks in the discharging and charging of the cell, until the cell has arrived at a steady working state for the current in question.

We give in fig. 11 an example of the time fall of the E.M.F. on breaking the circuit for eight periods of 20 seconds during the charge. The curves are all drawn to the same scale, but, in order to get the curves into a reasonable space, a different zero line has been employed in drawing each curve. The actual E.M.F. in volts per cell is given for several points on each curve, so that the time rise at any period of the charge can be easily seen. The E.M.F. at the moment of breaking the circuit in each case is, as already explained, obtained by seeing at what point the curve cuts the vertical line through the time 0. The value of this point in volts is, in fact, what an infinitely dead-beat voltmeter would indicate immediately after the circuit was broken.

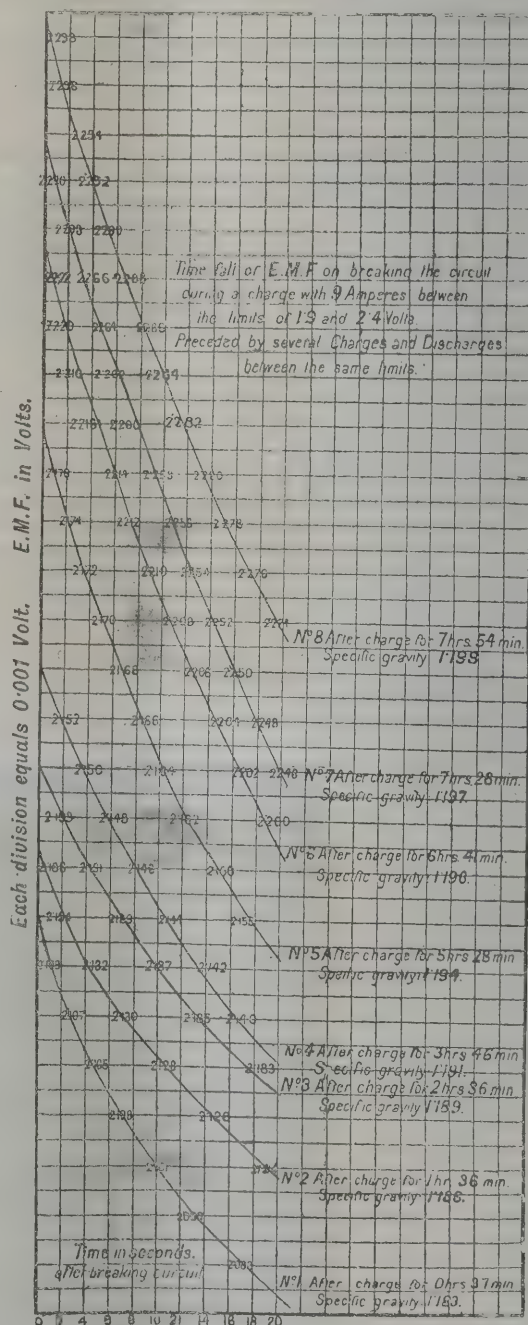


FIG. 11.

It will be observed that the time fall of E.M.F. on breaking the circuit becomes more and more rapid as the charge continues.

The top curve in fig. 12 gives the P.D. at the terminals of one accumulator, charging with 9 amperes; while the second curve gives the simultaneous values of the E.M.F., being, in fact, the curve drawn through points whose abscissæ are the times—0 hours 37 min., 1 hour 36 min., &c.—for which the eight curves on fig. 11 are drawn, and whose ordinates are the values of the points where these curves cut the vertical line drawn through the zero of time in fig. 11, or time when the charging circuit was broken. The lowest curve on fig. 12 gives the resistance of the cell at any

moment during the entire charge with 9 ampères, the ordinates of this curve being calculated from the formula

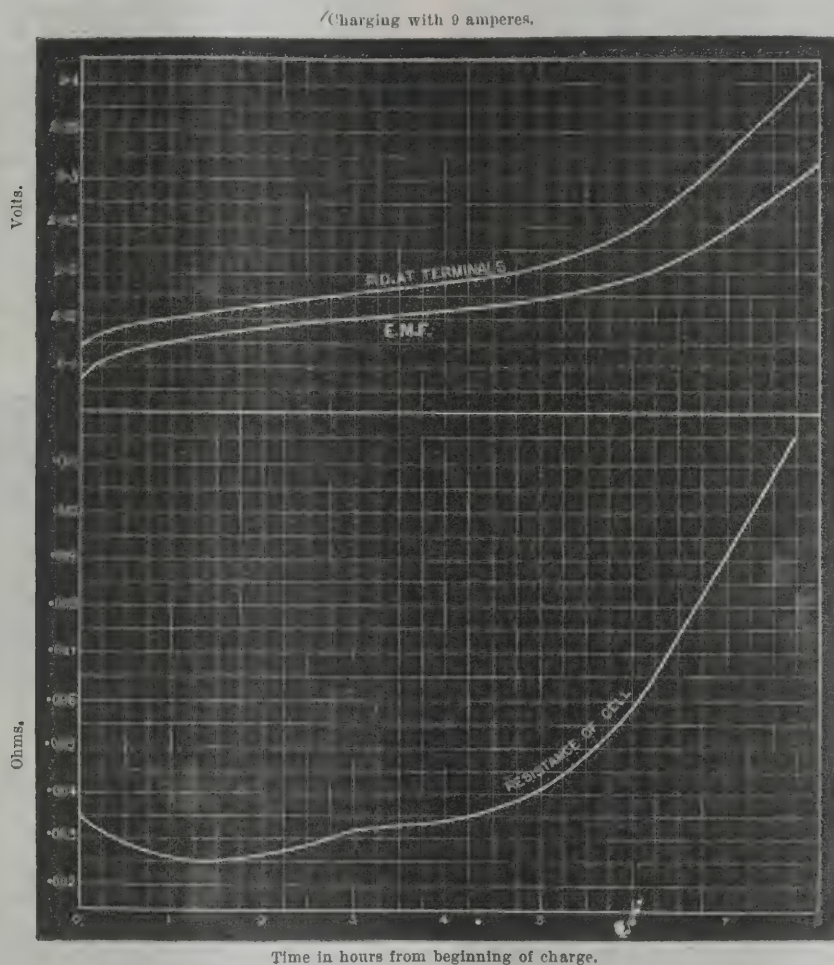
$$\frac{V - E}{9},$$

where  $v$  and  $E$  are values of the P.D. and the E.M.F. of the cell at the same instant.

As the charging proceeds the resistance of the accumulator at first falls, and reaches a minimum; it then increases, at first

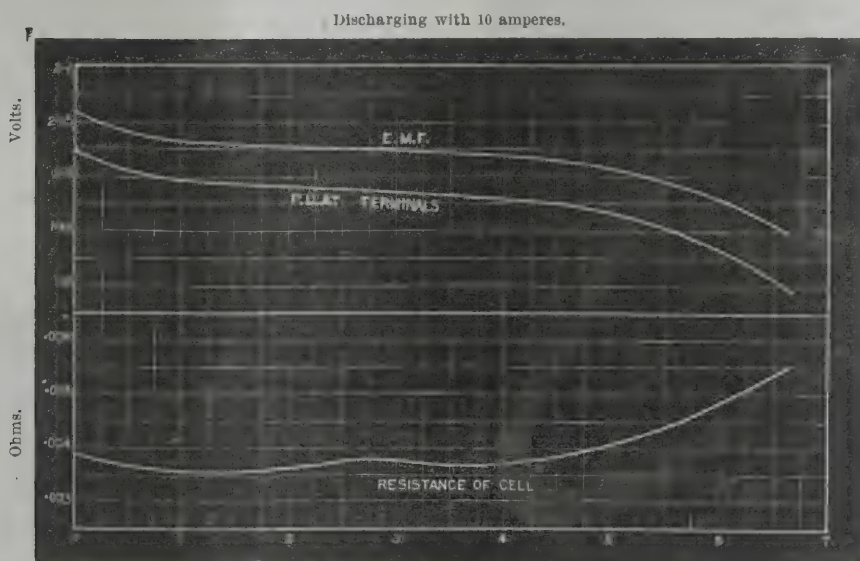
density allowed—viz., 3.787 ampères per square foot—is about 0.11 ohm per square foot of positive plate.

Fig. 13 gives the P.D. at the terminals of one of the cells during the whole of a discharge with 10 ampères, the simultaneous values of the E.M.F. and of the resistance. The resistance at the commencement of the discharge is a little higher than at the commencement of the charge, and the minimum value to which it diminishes is not as low as the minimum attained by the resistance in charging. At the end of the fifth hour of discharge



Time in hours from beginning of charge.

FIG. 12.



Time in hours from beginning of discharge.

FIG. 13.

slowly, but as the charging approaches the finish the resistance rises very rapidly, so that when the P.D. per cell is 2.4 volts the resistance is five times as great as its minimum value, which is reached shortly after the commencement of the charging. Taking 0.045 ohm as the average resistance during charging, and remembering that there are in these cells two positive plates each surface of which is  $9\frac{1}{4}$  into  $9\frac{1}{4}$  inches, and that all four surfaces are equally active, it follows that the mean resistance of the 1888 E.P.S. type of cell while charging with the maximum current-

and charge the resistance is practically the same. After that however, there is a marked difference: the resistance in discharging does not rise as rapidly as in charging; and hence, since, in addition, the time of a discharge is necessarily less than of a charge, the resistance never reaches as high a value in discharging as in charging.

If we take 0.038 ohm as the mean resistance during a discharge with 10 ampères, then it follows that the mean resistance of the 1888 E.P.S. type of cell while discharging with the maximum

current-density allowed—viz., 4.208 ampères per square foot—is about 0.09 ohm per square foot of positive plate.

Both in charging and in discharging with constant currents, the greater part of the time variation of the P.D. at the terminals of an accumulator is due to an actual variation in the E.M.F. itself; and it is only towards the end of the charge and of the discharge, when the resistance of the cell becomes relatively large, that the slope of the P.D. curve becomes practically different from that of the E.M.F. curve.

We may mention, in conclusion, that the results which we have obtained with accumulators made to go for long periods through definite cycles in charging and discharging, have been so interesting that we are now engaged on the design of an apparatus which will automatically keep the current constant for any time at any pre-arranged value, which will automatically change over from charge to discharge, or from discharge to charge, when the P.D. per cell reaches any pre-arranged limit, and which will record the P.D. at the terminals of the cell, and also its E.M.F. during the whole period.

We hope, therefore, at some future period to be able to present a graphical record of the life-history of accumulators from their first formation to their death.

"On Some Experiments in Radiometry."\* Paper read by A. R. BENNETT, Member.

In the course of some experiments with radiometers, the author has been able to detect effects which are of interest, and which, if observed before, have not been published, so far as he is aware.

Some of the experiments detailed may not bear any apparent relation to electricity; but the fact that electrical vibrations and those which give rise to heat and light, are now admitted to be but different phases of the same phenomenon, must be the author's excuse for troubling the Institution with them.

Rotations of the vanes of ordinary radiometers can readily be produced by electricity.

An unusually sensitive radiometer placed between the poles of an influence machine (fig. 1) has its vanes strongly affected. As a rule, oscillation to and fro only is set up, but this may readily be converted into rotation by timing the impulses from the machine to the swinging of the vane, or by giving the vane an initial start by lighting a match, or jerking it. Then rotation continues so long as the machine is worked. Generally, but not invariably, the motion, if not started mechanically in the reverse, is in the same direction as would be produced by heat. After the machine stops, the vane continues to rotate for a time, even after the knobs of the machine are brought together; and when it is stopped, a single impulse is sufficient to set it off again. In the dark the bulb appears filled with the usual phosphorescent light.

The effect appears at least partly electroscopic, since, on starting, the nearest vane is usually attracted toward, and then repelled from, the knob.

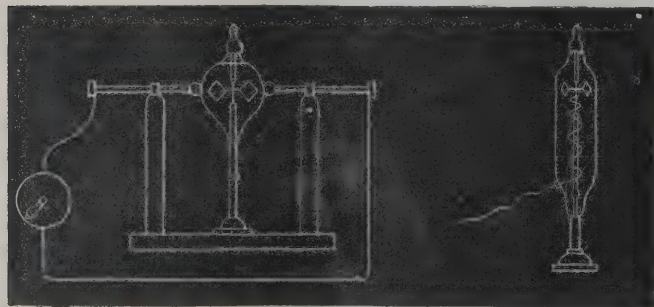


FIG. 1.

FIG. 2.

Placed against one pole only of the machine the vane oscillates feebly, but can be nursed into rotation.

With radiometers of special make more marked effects can be obtained. Several instruments having vanes fitted with metal caps, working on pivots connected to the outer air by wires fused in the glass were prepared (fig. 2).

Such radiometers really form condensers or Leyden jars, having the inner coating—the vane—free to move. The dielectric is the rarefied air, and the glass the outer coating.

When the vane is connected to one pole of an influence machine, it rotates until the condenser, of which it forms a part, is fully charged, and then stops; when the current is arrested, the vane rotates again in the same direction, until the greater part of the charge has been lost. So, by timing the impulses from the machine, continuous rotation can be produced. In the four-vaned instrument on the table the motion produced is in the reverse direction to that due to heat, the black being seemingly attracted; but in that instrument the vanes are bent at an angle which would naturally render the impulses effective in the direction indicated. In the two-vaned instrument also shown the vanes have no bias, and the motion is sometimes in the one direction and sometimes in the other. This charge and discharge effect is

produced feebly when the instrument is standing in the air, the vane only being connected to the machine. When the glass is brought near to or touches the opposite pole, it becomes more pronounced; and when the glass is coated with tinfoil and put in contact with the opposite pole, it becomes strong and invariable. If the foil is removed out of actual contact, but retained within free sparking distance, the vane no longer has periodic dead points, but discharges constantly to the outer coating, and rotation continues so long as the machine is worked. The process may be reversed by connecting one pole to the foil, and drawing the sparks from the vane by means of its connecting wire. The direction of rotation continues, however, as before. If the end of the vane wire be of small gauge—No. 40, for instance—it vibrates violently while discharging and with such rapidity that it seems double-ended, two perfect, and, apparently motionless, images of the ends appearing half an inch or more apart.

Continuous rotation may likewise be attained by means of an automatic discharger consisting of a strip of foil hanging from the outer coating of the radiometer opposite a contact point, which may be earthed or connected to opposite pole of machine (fig. 3). The foil diverges from the glass when the condenser gets charged up, and, making contact with the point, is discharged and falls back, only to be again repelled. (Experiment shown.) By this means the condenser is automatically prevented from becoming full, and the vane rotates so long as it is supplied with electricity from the machine. Conversely, the foil may be charged and the make-and-break performed by means of a light wire attached to the vane connection.

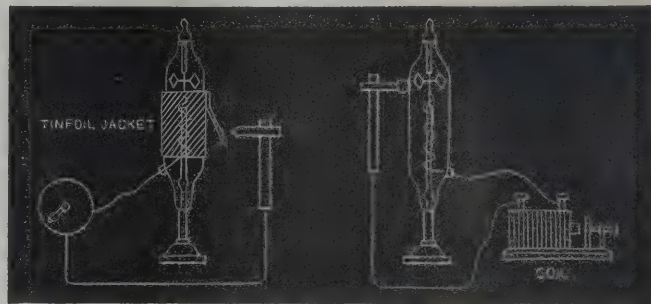


FIG. 3.

FIG. 4.

The radiometer with only one arm and two vanes is extremely sensitive, and exhibits the foregoing condenser effects in a marked degree. While charging or discharging it revolves with such rapidity as to make the arm appear a circle; and when fitted with an automatic discharger, each secondary discharge after the main one has been effected is accentuated by a kick. The rotation in this case is right and left indifferently, apparently according to the direction in which it first obtains an impulse. (Experiments with this instrument were shown after the paper.)

Experiments were made with these radiometers with the current from a Ruhmkorff coil.

Placed between points or knobs connected to the secondary of the coil, an ordinary radiometer could be got to rotate if an initial jerk were given, either to left or right. Left to itself, it oscillated only, the tips of the vanes being alternately attracted towards the knob and repelled from it.

With a special radiometer connected as in fig. 4, oscillation only could be got with dry glass; but on wetting the circumference of the tube round the vane, rotation was immediately set up in the reverse direction to that caused by heat, and continued until the glass dried. Merely breathing on the glass caused rotation to recommence. The effect cannot be wholly due to the fact that the moisture made a conducting ring round the glass, as a band of tinfoil had no result unless wetted on the outside, when very feeble rotation began.

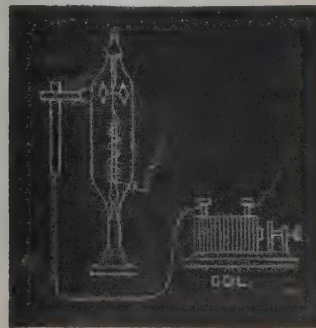


FIG. 5.

Rotation also occurred with wetted glass with connections as in fig. 5, the vane and one end of the coil being insulated.

In these induction coil experiments the silver side of the vane seemed uniformly repelled and the black attracted.

All the foregoing experiments exhibit beautiful luminous effects when viewed in the dark. Streams of phosphorescent light pass

\* Paper read at the special meeting of the Institution of Electrical Engineers at the Edinburgh International Exhibition, July 17th, 1890.

between the vanes, especially their edges, and the glass. The two-vaned instrument may be made to rotate by connecting one terminal of the coil to the vane and holding the other in one hand; two fingers (wetted) of the other hand being placed on opposite sides of the glass, rather under the level of the vane. The formation and disappearance of the lines of force between the wet finger tips and the edges of the vanes as they alternately approach and recede, then become vividly apparent.

Radiometers of this construction being really Leyden jars, a good deal depends on the glass of which the instruments are made. A radiometer made of a different glass from those now before you exhibited rotation freely with coil when dry, although wetting increased the effect. With that instrument an air-space of one-eighth of an inch could be interposed between the knob and the glass without stopping the movement; and making the connection with the glass by means of a wetted finger quickened the rotation.

But the author, wishing to discover how far the effects were due to the rarefied air, broke the glass. It was found that the movements continued for a time after air was admitted, but ceased as soon as the inside of the tube became damp.

But the moment the tube was broken it became apparent that the vane was subject to new influences, and was even more sensitive in responding to them than it had been to heat or electricity whilst still in its prison of rarefied air.

Poised in the open air, it became an indicator of the utmost delicacy of air currents set up or altered in direction by the approach or movement of heated bodies. When placed in a quiet room, free from draughts, the movement of the person from one place to another, however slowly and carefully it might be managed, was sufficient to set the vane in motion. The approach of the body close to the vane—softly, so as to avoid the mechanical creation of draught—would agitate it powerfully, and frequently rotation for several seconds would be set up.

Experiments were tried with vanes of various substances, with and without lamp-black, but the rotation seems altogether independent of the character of the vane. Anything very light will do, and paper does as well as talc or aluminium.

When the light of the sun or of a lamp, or the heat of a kettle is made to fall on one side of the vane only, continuous rotation towards the light or heat is set up. In a dark room, without a fire, the light from a lamp was made to shine through a funnel of small diameter (fig. 6), so that one side of one of the fans only was illuminated at the time. After some hesitation and preliminary oscillation the fan invariably advanced towards the light, and continued to rotate in that direction so long as the persons in the room kept 12 or 14 feet away, remained quiet, and refrained from changing their positions. The movement of a person only 3 or 4 feet, however cautiously, would cause the vane to hesitate and stop for a moment or two, and the crossing of the room always violently disturbed the vane, sometimes causing the rotation to

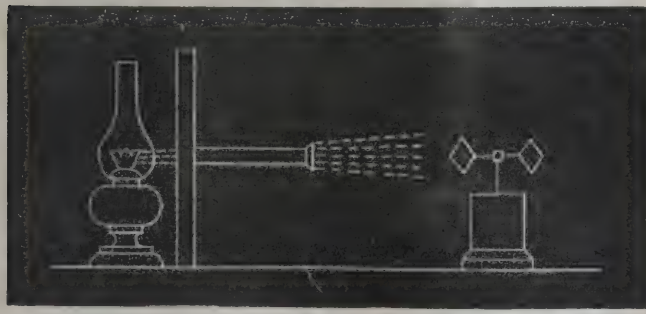


FIG. 6.

be reversed for a time. But when the body was kept stationary in its new position the old rotation toward the light recommenced, and continued until again disturbed.

This, and the facts that rotation is set up, and motion already existing is arrested, by the mere proximity of the person, seem to indicate that every living body and every object of a temperature higher than the surrounding air constitutes a field of force. It heats and rarefies the air around it, which ascends under pressure of the heavier and colder outer air. Every person not in the vicinity of bodies as warm, or warmer than himself, is a centre towards which air is always advancing from all directions, and on every plane from his feet to his head. On reaching him it is heated and ascends, so that he is surrounded by a column of air, warmer and lighter than the general mass, and always in motion upwards. The light and delicately balanced vane is sensitive enough to reveal the presence of the resulting horizontal air currents. This is probably the explanation of the experiment shown in fig. 6. The side of the fan facing the lamp, radiating the heat it receives, rarefies the air in front of it, which ascending, the fan is forced forward by the greater pressure of the colder air behind it. Each fan in turn, as it comes under the ray of heat, is subjected to the same influence, and so rotation is attained towards the lamp.

The movement of a body from one part of the room to another changes the direction of the air currents in the room, and creates eddies and whirls which disturb the vane for a time. If the body is placed behind the vane, or close beside it, it neutralises or reverses the influence of the heat ray from the lamp, and stops rotation. So the further away the observer places himself the better for the experiment.

The motion of the air toward the body can be shown by two vanes partially screened from the body, and wholly from each other, as in fig. 7. The outer fans of each vane will advance toward the observer, and the two vanes will consequently rotate in different directions under the influence of cold air advancing towards the body. It is curious that the first movement of the vanes in presence of a ray of heat indicates repulsion.

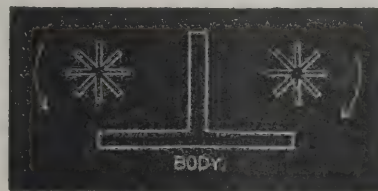


FIG. 7.

It occurred to the author that a complete circle of light material should show the currents as well as a vane, and on making a cap of tissue paper and balancing it on a needle point, it proved to be so. The cap is, under some circumstances, more delicate than the vane, and more sensitive to heat than the most sensitive Crookes's radiometer that could be procured. It was found that when a vane or a light paper cap was placed within a circular screen not quite closed (fig. 8), a ray of heat suffered to fall on the screen near the

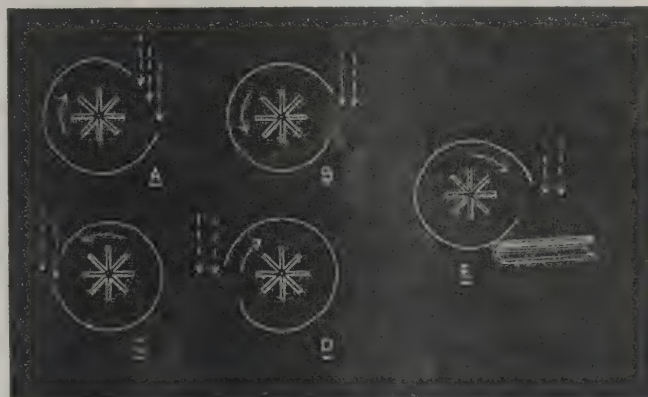


FIG. 8.

opening would set up air currents and rotation of the vane or cap, which would continue as long as the heat was applied. The direction of rotation depends on the form of the aperture in the screen. When opened out, as in A, fig. 8, so that the heat indicated by the dotted arrows falls partially within the screen, the vane or cap is repelled from the source of heat; when, as in B, the ray falls on the back of the opening, it is attracted. The direction of rotation may thus be changed by adding to the screen; when, as in C, the vane is being attracted, the placing of a book or other object, as in E, immediately causes it to stop and reverse.

This arrangement is of extreme sensitiveness. If the observer keeps well away, rotation will continue after sunset and under a cloudy sky, when the opening of the screen is exposed to the window. It excels in this respect a Crookes's radiometer of ordinary make, which on several occasions was noticed to give up work before the screened paper cap. Simultaneous rotation of two

FIG. 9.

FIG. 11.

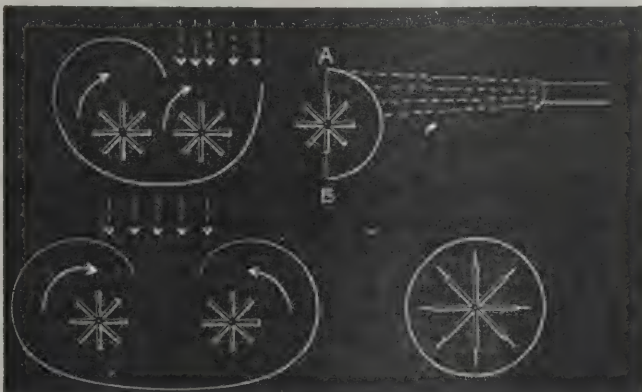


FIG. 10.

FIG. 12.

vanes or caps in the same (fig. 9) or in different (fig. 10) directions may be secured with one screen.

The movements of neighbouring bodies are not of so much importance as with unscreened vanes, as except in the direction of the opening exterior influences, unless very violent, are inter-

cepted. Placing the body across or near the opening disturbs, and will even stop, rotation.

Rotation may be set up by applying heat to the exterior of the screen. Thus, a ray of heat falling at A or B (fig. 11) causes rotation.

Vanes or paper caps, protected from the outer air by glass clock-shades, will rotate under sunshine or other source of heat, direction being determined by position in respect to wall of shade.

Rotation is produced by placing a heated screen round a vane. Thus, if a tinned iron screen be taken and heated, either uniformly or at one or more points, it will when placed over a vane immediately set up rotation which will continue, even in the dark, until the screen has cooled to the temperature of the air.

Similarly, a vane inside a screen of good conducting material, as metal, will rotate when heat is applied to one point of the exterior of the screen. This can be shown by applying the tip of a hot poker to the outside of a tinned iron screen.

Although rotation occurs best in screens having an opening to the outer air, it will take place when no such opening occurs, as in fig. 12. Thus, a vane inside a metal cylinder will oscillate and then rotate when heat is applied to the exterior of the cylinder. With thin metal, the application of the finger to the metal is sufficient to impart motion.

These motions are probably due to the same cause as that of the unscreened fan (fig. 6). The screen radiates the heat it receives from the impinging ray; the air next the screen is warmed and made to ascend, and is replaced by colder air advancing on all horizontal planes. The course of the currents is determined by the form of the recess enclosed by the screen; when the form is circular or snail-like, a well-defined whirl or eddy is established, and so continuous rotation is imparted to the vane or cap. The movements caused by a screen heated before being placed round a vane, or subsequently heated at one or more points by the application of a poker to its exterior, probably have a similar origin. That the currents causing motion are horizontal seems proved by the fact that the fans of the vanes used were strictly vertical, and therefore not adapted for indicating ascending currents; and the light tissue caps supported on fine needle points would be apt to be lifted off their supports and overturned by ascending currents, whereas they rotate horizontally for hours together. Yet that ascending air plays an essential part in the phenomenon is proved by the fact that covering the top of a screen stops the motion.

A hot vane placed within a cold screen will rotate until it cools; so the condition necessary to secure rotation appears to be a difference of temperature between the air and the screen or vane.

Screens of various kinds were tried, of high absorptive power, like white paper and paper faced with lampblack, and of high reflective power, like bright tinned iron. All answer well, but the tinned iron best. With a bright snail-like screen the difficulty is not to get the vane to rotate but to stand still. Notwithstanding the vigorous motion of the vanes, exploration of the interior of the screens by suspended silk fibres does not reveal the existence of such powerful currents as might be expected.

A vane at rest will be disturbed by a new object, such as a book being placed near it, however gently the act may be performed in order to avoid creation of an actual draught. It will, after some seconds of oscillation, and perhaps a few complete turns, adjust matters with its new neighbour, and again become quiet. The placing of a similar book on the other side will renew the motion, which always follows the withdrawal or addition of an object. With a sensitive vane, alternate deflections to the right and left may be brought about by the shifting of books.

A comparison between these results and those obtained with the radiometer is inevitable. With modifications consequent on the attenuation of the air in the latter instrument, the action in both tending to the establishment of currents of defined direction, is probably identical.

The discharge from an influence machine, directed across the openings in the screens, will cause rotation of vanes, or caps within them, as will the establishment of draught, however created.

For the instrument consisting of a vane, cap, or sphere, within a screen, the author proposes the name of radioscope.

After experimenting with vanes and caps, it was determined to try spheres.

Some India-rubber balloons were distended and hung by fine silk threads, such as are used for suspending the needles of astatic galvanometers.

All the effects produced by the vanes and caps were observed, modified by the winding up of the thread consequent on rotation, and some curious ones in addition.

A balloon was found to invariably turn one particular face to the observer on being approached, and this face it would keep toward him wherever he moved, so that he could cause it to rotate by walking slowly round it. A lamp, kettle, or other source of heat, carried round, had the same effect. Observation showed that India-rubber balloons are never truly spherical when distended, and that one side is always a little lighter than the other, and that it was the light side that always turned to the heat. The effect may be accentuated by gumming a piece of paper or foil on one side, so making it heavier. No effort on the part of the observer can induce the paper or foil to face him. Wherever he goes it immediately retreats as far from him as it can.

If a fairly spherical balloon is surrounded by a zone of paper, hung on a fine fibre, and allowed to attain a state of rest, it will,

when subjected to heat, begin to swing to and fro, towards and from the heat, and then to rotate slowly. (Fig. 13).

This effect is increased if the zone of paper is wetted, or one of wet linen used.

Generally, a few seconds after turning on the heat rotation begins, continues for a few seconds only, ceases, and then reverses. The rotation in the second direction is much better sustained, and will continue until the force acting is counter-balanced by the winding up of the fibre.

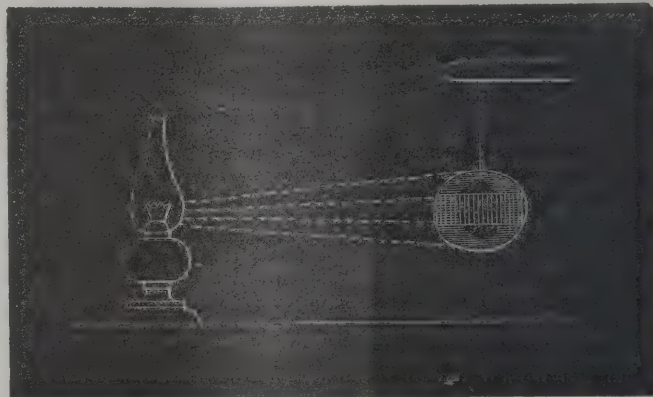


FIG. 13.

It being evident that evaporation exercised a powerful influence on the action, and the manipulation of wet paper belts being inconvenient, about half an ounce of water was put into a balloon before it was blown out, and this yielded a very convenient, and, at the same time, fairly sensitive instrument.

After shaking the water about so as to well wet the interior of the balloon, it was hung on a single silk fibre and left in the dark to come to rest, which having done, a lamp was caused to shine on it from a distance of 3 feet. After swinging a bit it turned some half a revolution to the left, stopped, and then began to rotate to the right, that is to say, in the reverse direction to the hands of a watch. After a few complete turns it paused, then continued for several turns more, sometimes pausing and going on without a reversal; sometimes reversing a little, and then continuing. When it finally stopped, the lamp was withdrawn a couple of feet, and renewed rotation was the result. Another stoppage soon occurred. The lamp was then withdrawn altogether, and rotation recommenced and continued for several more turns. The experiment was repeated many times with slightly varying, but substantially the same results. The best results were, however, attained with balloons belted with foil, and by keeping the lamp 3 feet off. When closer, rotation was not so long continued.

Suspending the balloon in a packing case, so that it is surrounded on three sides by wood, increases the uniformity of the results, although they occur markedly when suspended unscreened in a room.

The rotation produced appears to the author to be identical with that of the vanes and caps. Although the particles of bodies and gases, air included, expand when heated, indicating repulsion, yet heated bodies have a tendency to motion towards each other through the rarefaction of the air between them and the presence of the heavier air behind, and motion will occur if the friction or other restraining forces are not too great. A heated body has similarly a tendency to move towards any other between which and itself its radiation rarefies the air. In the case under consideration a cone of heat from the lamp falls on the balloon, and is radiated, rarefying the air between them, and causing the balloon to slightly approach the lamp. The perpetual endeavour which follows to adjust between this horizontal force and the vertical one due to gravity may cause the balloon to rotate, although air currents due to heat radiated from the balloon probably help. A difference of temperature between the different parts of the balloon is obviously necessary. All the results point to this stoppage and reversal after the lamp has been shining some time, and subsequent continuance. The stops and reversals give the balloon time to cool by radiating to the walls of the packing case and other surrounding objects. When equally heated all round there is no tendency to deflection and no rotation.

The resumption of motion after the withdrawal of the lamp may perhaps be explained in the same way, the heated balloon now replacing the lamp as the source of heat, and acting with the walls of the room or of the packing case. When cooled by radiation to the same temperature as surrounding objects it comes to rest.

The correspondence between the effects produced by the charging up of the vane of the radiometer and its subsequent discharge, and the heating up and subsequent cooling of the balloon is noteworthy. In each case motion is produced by the charging process, until the limit of capacity is reached, and after a dead period, corresponding to the full condition, is resumed during the discharge or cooling.

This class of experiment, to ensure success, requires the observance of stringent conditions. The room should be dark, its fireplace closed, and every other precaution taken to exclude draught. At most, two observers should be present, and they should keep as far from the balloon as possible and remain still.

The suspending fibre should be single, as deceptive rotation may be got by the untwisting of a double thread; and the balloon must be hung up and left in the dark to come to rest before having the heat turned upon it. The lamp used should be the sole illuminant in the room. For these reasons I have not attempted to reproduce the experiments in a hall like this. A balloon as truly round as possible should be used—a flat side will not pass the lamp, but oscillates alternately to the left and right before it.

The direction of rotation appears capricious, although extremely well marked and persistent when once started. Possibly it is determined by the suspending fibre retaining some directive force, but the matter has yet to be properly investigated.

By far the greater number of experiments gave rotation in the reverse direction to the motion of the hands of a watch. Sunlight suffered to fall on the balloon through an opening may be substituted for the lamp. A kettle of hot water, or even the close approach of the hand or the body to a balloon suspended by a single cocoon fibre will start rotation. Between each experiment the balloon should be lifted off and the fibre allowed to untwist. The violence with which it does this after prolonged rotation shows that the work done by the force, whatever it may be, is by no means inconsiderable.

The resemblance of the rotation of a balloon under the influence of heat applied to part of its circumference to that of the earth is certainly striking, although it may seem far-fetched to compare the world with an inflated windbag. Like the balloon, the earth receives heat on one side, and radiates it on the other, and evaporation (when the wet zone is used), combined with expansion of air, occurs in both cases. It is true the balloon has its atmosphere inside its shell, but the shell is elastic and capable of distortion in the direction of the heat, a distortion which may possibly have something to do with the motion.

The author regrets that, owing to the putting forward of the date of the meeting of the Institution in Edinburgh by a couple of months, the experiments are not so complete, nor the explanations so exhaustive and satisfactory as he should have liked them to have been.

## APPENDIX.

*Notes on Rotation of Spheres.*

India-rubber balloon	simply distended	Will deflect and oscillate but not rotate.
Do.	covered with film of water	Will rotate until film has evaporated
Do.	with zone of dry paper	Will rotate slowly and intermittently.
Do.	with zone of lamp-black paper	Will rotate slowly and intermittently; motion excessively slow.
Do.	with zone of wet paper or wet linen	Rotation much quicker, freer, and longer sustained. Many trials gave average speed as one turn in 1.25 minutes. Between the two stages of heating and cooling, motion in the same direction will continue for an hour.
Do.	with $\frac{1}{4}$ oz. of water inside	Rotation not so free as foregoing, but arrangement more convenient.
Do.	with zone of tin-foil	This gave the best results. In some cases rotation in the same direction continued between heating and cooling for over three hours, the number of turns being from 150 to 160.

With some of the arrangements, notably, the wet paper zone, a lamp is unnecessary. If the balloon is suspended breast high, the careful approach of the body so as not quite to touch will induce rotation. Balloons of French make, which may be purchased at most India-rubber shops, are best, as they are lighter and far more symmetrical than English or American.

## NEW PATENTS—1890.

11402. "Improvements in couplings for electric railway vehicles." L. PFINGST. Dated July 21. (Complete.)

11440. "Electric railways." F. MANSFIELD. Dated July 22. (Complete.)

11465. "Improvements relating to riveting by the aid of electricity." M. W. DEWEY. Dated July 22. (Complete.)

11466. "An improved electro-magnetic friction clutch." T. M. FOOTE. Dated July 22. (Complete.)

11480. "Improvements in dynamo-electric machines and electro-motors." E. THOMSON. Dated July 22. (Complete.)

11499. "Improvements in dynamo-electric machines." A. E. WADLEY. Dated July 23.

11601. "A process for obtaining metals in molten condition from their fused oxides by electrical action." A. H. COWLES. (Communicated by F. W. Matthiessen, United States.) Dated July 24.

11653. "Improvements in and connected with the electric propulsion of vehicles on railways and tramways." W. E. HEYS. (Communicated by J. J. Heilmann, France.) Dated July 25.

11657. "Improvements in electric dental pluggers." W. E. GIBBS. Dated July 25. (Complete.)

11679. "An improved electric connection." W. W. HORN. (Communicated by H. Sanche, United States.) Dated July 25.

11690. "Improvements in electro-magnetic separators for extracting metal from slag and the like." P. U. ASKHAM and W. WILSON. Dated July 26.

11699. "Process for obtaining chlorine and bromine by the aid of electricity." G. NAHNSEN. Dated July 26. (Complete.)

11720. "Improvements in connection with electrical fuses." R. J. JONES and G. WORRALL. Dated July 26

11737. "Improvements in posts or pedestals for electric arc lamps, in the arrangement and mechanism of arc regulators, in guide apparatus for carbon holders, and in apparatus for automatically cutting an arc lamp out of circuit." F. W. ALLCHIN and J. LEA. Dated July 26.

## ABSTRACTS

## OF PUBLISHED SPECIFICATIONS, 1889.

6544. "Improvements relating to electric incandescence lamps." A. A. GOLDSTON. Dated April 16. 8d. Each of the leading in wires has a contact piece attached to it, and between the two contact pieces is arranged a cone or wedge of insulating material. To the large end of the cone or wedge is attached a metal piece which is adapted to complete the electric circuit through the contact pieces, and to the small end of the latter is attached one end of a spring, the other end of which is connected to the head of the lamp. This spring normally tends to draw the metal-piece on the cone or wedge into contact with the contact pieces, but is prevented from doing so while the carbon or light-giving conductor is intact, owing to the fact that the said carbon or conductor is sufficiently strong to prevent the leading-in wires from expanding to allow the cone or wedge to be drawn towards the contacts. Should, however, the carbon or light-giving conductor be destroyed, the cone or wedge and metal piece are moved under the action of the spring, and so make the desired contact. 5 claims.

6572. "Improvements in dynamo-electric generators and motors." G. E. DORMAN. Dated April 17. 8d. A dynamo-electric generator or motor constructed according to the invention consists of two castings of iron bolted together and forming a rectangular or box-like structure, each casting being one-half of said structure and being of trough section, and interiorly and against and integral with the bottom of each casting, and centrally located, is situated a pole piece, and on the ends of each casting and integral therewith are formed ends or brackets which contain a half boss, such ends or brackets when the castings are bolted together partially or entirely enclosing the ends of said rectangular structure aforesaid, when the castings are thus bolted together the pole pieces and bosses are bored out at the same time, or at the same sitting, so as to support centrally between the pole pieces an armature. 4 claims.

6675. "Improvements in electrically-driven fans." H. G. WATEL. Dated April 18. 6d. The inventor converts the rim of the fan into the armature of an electro-dynamic machine, or applies the ring armature of such a machine to the periphery of the fan, and he converts the fixed framing within or against which the fan works into field electro-magnets, or he applies such field magnets to the framing. The coils of the armature, or those of the field magnets, are connected to a suitable commutator on the axis of the fan, and thus when the machine is put in circuit with a suitable source of electricity, the fan is caused to revolve by the magnetic action applied at its periphery. 2 claims.

7856. "Improvements in electrical transformers." W. C. JOHNSON and S. E. PHILLIPS. Dated May 10. 8d. The inventors construct the core of thin soft iron plates or laminae separated from each other either by being coated with a varnish containing French chalk, or by the interposition of paper, such plates being so formed as to afford angular or chamfered faces at the ends of the core. After winding upon the core so formed the primary and secondary coils, they surround them with bars similarly built up of thin plates, having a curved or angular or U-shape at the ends formed either by bending or stamping, and which have angular or chamfered faces so formed as to fit accurately against the chamfered faces of the core, the whole being thus made to present the shape of a closed loop or chain link, with a bar, constituting the core with its coils, passing across its middle, the separate plates forming the loop and core lying either parallel to the plane of the loop or at right angles thereto. 5 claims.

9166. "An improved electrical repeater and commutator, to indicate the normal position and the movements of railway or other signals, slots, and the like." D. WELLS. Dated June 3. 8d. Claim:—1. The obtaining of indications on the electrical repeater of three or more distinct and different movements of the signal arms, rods, slots, and the like; using a single-line wire, and with the battery placed in the signalman's box; by bringing a resistance coil or coils into circuit between the commutator and the "earth" connection, and providing an adjustable supplementary backweight or check in the electrical repeater to ensure accurate indications.

9241. "Improvements in electric meters." A. A. CAMPBELL SWINTON. Dated June 4. 11d. The inventor causes a suitable body to vibrate reciprocally in unison with the alternations or periods of the current, the amplitude of such vibrations being proportional to the strength of the said current, and he causes the vibrations of the body to actuate a suitable recording or counting apparatus in such a manner that the said counting apparatus is moved forward at each vibration through a space proportional to the amplitude of the vibration, and consequently to the strength of the current, so that, the periodicity being constant, the counting apparatus in a given time is moved through a space proportional to the total current that has passed during that time. 5 claims.

9571. "Arrangement of circuits and apparatus to be used in connection with telephonic communication." J. E. KINGSBURY. (A communication from abroad by F. E. Welles, of Antwerp.) Dated June 8. 8d. Consists in the arrangement of the circuits and apparatus, so that the annunciator drop of one subscriber is cut out of the line, and only one spring jack is used for each subscriber. 8 claims.

9917. "Improvements in switches used for electrical purposes." F. B. NICHOLSON. Dated June 17. 6d. The inventor uses a centre contact piece, turned taper, and working in suitably constructed contact pieces after the manner of a gas or water tap, and so arranged that when the centre contact piece or bar is in one position that the metallic or electric circuit is complete or in another position it is broken. 2 claims.

## CHOOSING A RUBBER BELT.

By ROBERT GRIMSHAW.

THERE having been expressed a desire for a table which would show about how much rubber belt cross section there was needed to carry various horse-powers at various speeds, the following table (*India-Rubber World*) is offered as being convenient and practical for horse-powers from 10 to 100 inclusive, and for belt speeds from 2,000 to 2,750 inclusive. The belt is supposed to be fastened with single leather lacing. Doubling the lacing adds about one-eighth to the driving power, other things being equal, and of course calls for only about eight-ninths as much cross section for a given horse-power. If the joints were riveted there would be required only five-ninths as much belt for a given power.

BELT CROSS SECTIONS.

Horse-power.	Belt speeds.		Feet per minute.	
	2000	2250	2500	2750
10	·7	·62	·56	·51
15	1·0	·7	·8	·8
20	1·4	1·2	1·1	1·
25	1·7	1·6	1·4	1·3
30	2·1	1·9	1·7	1·5
35	2·4	2·2	2·	1·8
40	2·8	2·5	2·2	2·
45	3·1	2·8	2·5	2·3
50	3·5	3·1	2·8	2·5
55	3·8	3·4	3·1	2·8
60	4·2	3·7	3·4	3·1
65	4·5	4·	3·6	3·3
70	4·9	4·4	3·9	3·6
75	5·2	4·7	4·2	3·8
80	5·6	5·	4·5	4·1
85	6·	5·3	4·8	4·3
90	6·3	5·6	5·	4·6
95	6·6	5·9	5·3	4·8
100	7·	6·2	5·6	5·1

Thus, if we have to carry 50 horse-power and know that we are going to have belts running 2,250 feet per

minute, we can see at once that it will take 3·1 square inches of cross-section rubber belt laced with single leather lacing, and having 180 arc of contact upon a cast iron pulley in good condition. We can make about this by having 12 inches of belt one-quarter inch thick or 15 inches of belt one-fifth inch thick; or if we know how wide we shall have to have our belt we can figure up very readily what thickness to get. Thus, if we cannot have more than a 10-inch belt we shall know very quickly that it will require 3·1 divided by 10, equal to 0·31 inch of belt thickness.

For other belt speeds than those given it will take in inverse proportion; thus, for 1,125 feet of belt speed per minute it will require double the quantity; that is, 30 inches of one-fifth inch belt, or 24 inches of one-quarter inch, and so on.

## CORRESPONDENCE.

### Accurate Measurement of Low Resistance.

Referring to Mr. A. Eden's article in the REVIEW of the 4th inst, we may mention in proof of the correctness and advantages of the methods described by Mr. Eden of "obtaining accurate measurements of low resistance by means of higher resistances in shunt" that for a number of years Messrs. Hartmann & Braun's rheostats and resistance bridges have been adjusted in this manner and thereby gained their high reputation for great accuracy. Their resistance sets of small resistance are all adjusted to their full value by a shunt of higher resistance inside the instrument, the main resistance being left a trifle too great and being silver soldered direct to the thick copper feeding wires. These instruments will therefore require no further shunts for the most accurate measurements.

O. Berend & Co.,

Representatives of Hartmann and Braun.

July 31st, 1890.

### Secondary Battery Manipulation.

In your issue of August 1st, Mr. Shippey points out that packing the plates with a mixture of plaster of Paris and sawdust does not prevent evaporation of the liquid. I never supposed that it did, but I pointed out in a former letter, that evaporation is greatly retarded if a little carbonate of soda be added to the electrolyte. On my own authority I should hardly have ventured to make this assertion, but my attention was first called to the fact by Mr. Probert who, at the time was carrying out a series of very careful experiments at the General Post Office on the use of sulphate of soda in accumulators, and I believe it was found that where two identical cells were standing side by side in a room during six warm months, one containing ordinary dilute sulphuric acid and the other sulphate of soda, that it was necessary twice to fill up the cell containing the ordinary dilute acid, whereas the cell containing sulphate of soda, never required replenishing.

W. J. S. Barber-Starkey.

August 2nd, 1890.

### Prof. Lodge on Alternative Path Experiments.

A passage in my communication which appeared in your last issue, owing to the accidental omission of a comma, might possibly, I think, convey the impression that Prof. Lodge was one of the scientific experts who gave evidence in the late case of King, Brown & Co. v. Anglo-American Brush Corporation. Perhaps you would kindly allow this letter to appear in your columns to correct any misapprehension to which the omission of the comma might give rise.

S. Alfred Varley.

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## THE DEBATE ON THE TELEGRAPH ESTIMATES.

THE recent passing of the telegraph estimates was characterised by an important and interesting debate. Important—because of the magnitude of the sum involved, and the extent of the service it promotes, and interesting on account of the absence, for once in a way, of those dry details and monotonous columns of figures common to the passing of estimates generally.

There were a few complaints at the outset as to the slow development of telegraphic communication in the more remote parts of the Highlands ; a difficult matter in which to suggest any specific course ; some general remarks at the conclusion from several hon. members as to the Carté system of telegrams as observed in Paris and elsewhere on the Continent ; a system said to be cheaper than our own, but less expeditious, and therefore of doubtful value to the commercial world ; comments on the non-purchase of the telephone interest, and the question of overhead and underground lines ; but these points cannot be said to have affected the general character of the vote.

The more prominent features of the debate were those raised by Earl Compton and Sir E. Reed. Indeed, Earl Compton and Sir Edward had openly expressed their intention of bringing matters affecting the telegraph service before the House on the discussion of this vote.

Whatever the Postmaster-General thinks of what he sarcastically terms the "endeavours of philanthropic politicians" in encouraging remedial agitation, he has but little reason to complain of the splendid and effective opportunity with which they provided him for the display of his own ideas of philanthropy and justice on the occasion under notice.

Earl Compton considered the answers given in the House of Commons from time to time, with reference to the Telegraph Department, very unsatisfactory. He disclaimed party motives, and had not taken any active part amongst telegraph clerks, whose movement had

been conducted legitimately and constitutionally. What they had done had been effected without the aid of paid or political agitators.

The Postmaster-General deprecated the interference of third persons between the Department and its servants.

The noble lord, on broader than departmental grounds held that departmental servants were, after all, the servants of the public, and not of the Postmaster-General ; on that ground hon. members had a right to interfere, if the exercise of constitutional and legitimate methods had failed to remove complaints of improper treatment.

Earl Compton evidently feels that the responsibility of the member to his constituency is of as much importance as is the responsibility of a minister of State to the House. Few will deny the soundness of this principle.

Proceeding into details of work, pay, and promotion in the Telegraph Service throughout the country, the noble lord displayed a surprising mastery of his subject, his knowledge of details being extensive and accurate. He complained of evasive replies ; of a difference between "Hansard" and *Times* reports, and preferred the latter. With reference to public meetings, he strongly advised the Government to allow civil servants to meet without interference, and took up much of the ground held by us in our leader of the 1st inst. He acknowledged that the Postmaster-General's scheme was infinitely better than he expected ; but was the Fawcett £190 class to be replaced by a new £160 class ?

This is the point on which the whole success of the new scheme turns. It is the point, too, which is still in abeyance.

Lord Compton dealt at some length on these and a number of other points, and, in moving the reduction of the vote by £150, said though the Postmaster-General had had a great deal of trouble, he thought much of it was due to his want of sympathy with those under him, but he still had a great opportunity of

reinstating himself in the affections of those over whom he was placed.

The noble lord's remarks were characterised by the temperate and yet candid manner in which they were presented, and he had a sympathetic following throughout.

Sir E. Reed, true to his promise, dealt forcibly yet fairly with what is known as the "Cardiff exiles" incident. Our readers will probably remember the circumstances of the case, and we need not reproduce them here. Sir Edward took up a very strong public position at the time, and from that position he has not swerved. He, too, disclaimed party aims, and said he was not anxious to make himself a medium for ventilating grievances in that House; and here he gave one of his cutlass-like slashes, just by way of a change, adding, particularly during the *régime* of the present Government. While he declined to unduly harass the Government, yet he thought there had been a desire to exercise arbitrary authority; but in this age discipline was not to be maintained by such measures. The House cheered this sentiment. He dealt trenchantly with the "exile" question. He had gone into the charge brought against the men; that charge was entirely without foundation. He strongly disapproved of the restriction of public meeting; any Post Office official inviting half a dozen of his colleagues to dinner, at which matters of interest to themselves were discussed, would be liable to dismissal.

The Postmaster-General had seen the gross absurdity of any such regulation.

By responding to the appeal to remove the grievances which Post Office *employés* were suffering under the Postmaster-General would probably save them the trouble of dividing on the vote. Another hon. member pointed out, as we have already done, that the order of 1866 was a dead letter.

The Postmaster-General rose, primed and loaded, apparently, with philanthropic anxiety and goodwill. In no other way can we record the spirit of his reply to his Parliamentary assailants.

We have already said that the Postmaster-General has but little reason to complain of the splendid opportunity held out to him by "philanthropic politicians," amongst whom he includes, presumably, Lord Compton and Sir Edward Reed.

Whether he does, or whether he does not, he nevertheless owes these hon. members a debt of gratitude. He had such an opportunity of vindicating his anxious zeal in the interests of telegraph clerks, that the absence of Lord Compton and Sir Edward Reed from the debate would have been little short of a catastrophe for him.

He hoped to maintain the temperate tone displayed by the noble lord. In sorrow, with just the necessary dash of anger, he rebuked the noble lord for disparaging "Hansard." Notwithstanding "the cannonade by insolent vituperation hurled at the head of the Department," complaints would receive the favourable consideration of the Government.

He hoped he had abstained from the use of irritating language. He thought it strange that he, who had been

the only Postmaster-General since Mr. Fawcett had been able to secure for the telegraphists permanent benefits, should be attacked as one guilty of unsympathetic and arbitrary dealing. He was happy to think, however, that he had been able to give to the telegraphists substantial proof of his consideration. On the subject of the prepared evidence for the Royal Commission, and which was at first sent through the "higher officials," the Postmaster-General was hazy and uncertain. He did not know much about that case. He admits, doubtless, that it was urgent. On several other points a want of knowledge also provided a ready escape.

The Postmaster-General then graciously took the House into his confidence, gloriously detailed the reforms and concessions in his scheme, and pathetically remarked that he had done all he could to show his regard for those under him.

The House heard these concessions in an appreciative spirit, as also the statement that with reference to the vexed question of maximum pay in the Central Department, telegraph clerks would find that their position would not be damnified, but improved. The Postmaster-General, notwithstanding all these advantages, is glad that he has not got to do the work of a telegraph clerk. Telegraph clerks ought not to lose sight of these statements.

Continuing to display a broad and almost amazing philanthropy, on the subject of public meetings, the Postmaster-General said the new regulations were intended to express to the servants of the department the "benevolent disposition" of their superior officers. This "benevolence" does not seem to extend to reporters who are not "official," as the Postmaster-General doubts the accuracy of their reports, and in this matter it will be seen that he, like Lord Compton, finds considerable variance amongst reporters.

In fact the Postmaster-General appeared to be running over with amiability, and the last good natured volley, in what many will call a remarkable speech, was made up of expressions of justice, kindness, benevolence and goodwill to everyone in his great department, and which department he ventured to hope he had not unworthily administered. It is not surprising that this speech disarmed further opposition, and that the vote was agreed to without a division.

From rebuking the "philanthropic politician" it will be seen that the Postmaster-General has arrayed himself from head to foot in a gorgeous and resplendent mantle of philanthropy. We trust the texture of this garment is not too transparent.

It remains for him now to see that his scheme is not tampered with by those who come between him and those to whom he has expressed such unbounded goodwill.

It will be worth his while to prevent delay in the general application of his reforms to the telegraph service, and to be careful that officialism does not underrate those points which have enabled him to pose, in what it is to be hoped is something more than a well simulated philanthropy before the House of Commons and the country. Already we hear of men being

punished for what they have said, and also of one man's dismissal on this score.

Many will ask if this is a specimen of the exercise of that "benevolent disposition" referred to in the Postmaster-General's speech.

If the whole thing is not an absurd and ill-timed parody, the Postmaster-General will see that his deeds outside the House are equal to his promises in; it will then be fully admitted that a little practice has lent additional value to much precept.

## ELIHU THOMSON'S NEW ALTERNATOR.

IN designing the machine, which figures on another page, the main object seems to have been to avoid the use of moving coils in an alternator having iron in its armature. The only machine made in this country and designed with the same object is, we believe, the alternator of Mr. Kingdon, about which, however, there has been up to the present a remarkable scarcity of data. But the idea is by no means new. In 1883 the late Mr. Charles Lever designed a machine in many respects similar to that of Professor Thomson, which was made for him by Messrs. Paterson and Cooper, and when finished, tested at their works.

The magnetic wheel or rotating pole-piece consisted of a star-shaped piece of wrought iron, like Professor Thomson's, but with eight spokes, while the fixed coils, 32 in number, arranged 16 on each side of the wheel, were wound on cores formed of split tube filled up with iron wire and attached to cast iron ring cheeks. The star wheel was carried by two upright magnets, and had all its spokes of the same magnetic polarity, while the lines of force completed their circuits in the machine by passing from the spokes through the cores of the fixed coils, then from the ring cheeks to the sole plate supporting the two magnets.

The points in which that machine resembled this of Prof. Elihu Thomson will be at once observable. It remains but to add that, when it was tried, Mr. Esson proposed a modification which would have made them almost identical, consisting in substituting for the two circles of coils on the sides of the spokes, one circle only to be wound on cores projecting inwards from a ring outside the spokes. But after experimenting for some time, Mr. Lever gave the machine up; for what reason we do not know. That he had a fairly clear notion of what he wanted to do is certain, though consequent on the state of knowledge at the time, his ideas were but imperfectly carried out. The magnetising coils induce in these machines a field having several separate paths, each of which is intercepted by a fixed armature coil. There is in each path a considerable air gap, and it is the function of the magnetic wheel to close and open in succession these gaps, so determining the successive magnetic paths the lines shall take, and inducing an E.M.F. in the fixed coils. Though there is no actual reversal of magnetism in the coil cores, there is a considerable surging of the field, and to avoid the heating which would otherwise result,

both the magnet wheel and the coil cores require to be laminated. This is done in both the Zipernowski and Kingdon machines, which Thomson's, to some extent, resembles.

*Invention made Easy.*

SEVERAL American exchanges just to hand give descriptions of converters and dynamos, devised by a Mr. De Castro, of New York, having their cores made up of iron filings. It is evident from the drawings which accompany the descriptive matter that the information given has been culled from a patent specification, and not derived from the results of practice. Respecting the construction of dynamo armatures we read that "experiments which the inventor has made lead him to believe that by the employment of cores of subdivided iron or iron filings in lieu of solid cores, he can secure inductive effects of much greater intensity than heretofore and effect a considerable economy of electric energy and insure the conversion of a greater number of lines of force or energy than has heretofore been possible." Mr. De Castro must be sadly behind the time, both with regard to subdivided iron and also filings. Of the former it is unnecessary to speak, and of the latter we need only remark that cores so made are absolutely useless. In 1879, Profs. Ayrton and Perry had a dynamo so constructed at the works of Messrs. Clark & Muirhead, and, perhaps, these gentlemen will be so kind as to enlighten Mr. De Castro on the results obtained by them, and so save him the expenditure of further time and money. Induction apparatus with iron filing cores had been tried, we believe, by Cromwell Varley, amongst others, previous to that date, and we cannot conceive how it is that so many of our American contemporaries continually insert descriptions of so-called new inventions without the slightest attempt to put the patentee on his guard against proceeding with old, abandoned, and useless ideas.

*Thunderstorms.*

THE article which we publish on another page will prove of interest to students of the phenomena of atmospheric electricity. There is no doubt that Prof. Oliver Lodge has recently done much to awaken an interest in the action of lightning, and it is just such papers as Mr. Hazens which are required to give one a good idea, in popular form, of the complex nature of thunderstorms.

*Electric Torpedoes.*

ALTHOUGH the Edison-Sims torpedo has been previously mentioned in our pages, it has not hitherto been noticed in such a complete manner as in this issue. It will be found interesting not only to military and naval readers, but also to the electrician.

*Open to Doubt.*

A TELEGRAM from Washington, dated August 9th, reads as follows:—"In view of the universal interest aroused by the Kemmler execution, an accident which occurred to-day to an *employé* of an electric light company at Washington has evoked great attention. By an inadvertence the man received a shock of 2,000 volts. He became

instantly insensible, but soon recovered, though the places where the current entered and left his body showed marks of burning, and were very painful." It is easy to get such a paragraph as this noised abroad with a view to show that there could have been no certainty that the electrical plant used upon Kemmler would send him into eternity swiftly and painlessly; but what is there to prove that the Washington workman received a shock from a pressure of anything like 2,000 volts? Moreover, we believe that the Westinghouse high tension system is employed in Washington, so the story of this wonderful escape from death may be open to various constructions.

Photographs of  
Water Drops.

THE demonstrations given by Mr. C. V. Boys of his photographs of falling water drops are well known, and Lord Rayleigh recently remarked that it had never occurred to him as being possible to obtain enough light from a single spark to photograph the drops as Mr. Boys has done, and he attributed this success to the fact of his using no lenses, which would absorb the ultra-violet rays. It is not, however, so generally a matter of common knowledge that Mr. P. Lenard succeeded very well some years ago in photographing water drops, falling through air, with single sparks, the light of the spark passing two glass lenses and the objective of a camera which gave magnified images. Copies of Mr. Lenard's productions appeared in the *Annalen der Physik und Chemie*, Vol. XXX., 1887, and show all the forms obtained by Mr. Boys. It may be interesting to state that Mr. Lenard has a paper in the same journal, No. 4, 1890, entitled:—"Leitungswiderstand von Wismuthdraht im Magnetfelde für Constante Ströme und Elektrische Oscillationen."

Too Modern.

*Modern Light and Heat* is too modern. In its issue of the 31st ult., we note the following:—"The electric railway accident in Boston on Saturday last by which two horses were killed was certainly an unfortunate one. It is a well-known fact that dumb animals, horses in particular, are of very sensitive nervous organizations and unusually susceptible to the electric current. That the public need have no more fear of the current since this accident than before, is substantiated by the fact that there is not a single case on record where a human being has been killed by a 500 volt current." Now we know of a death which occurred in this country some years ago from a continuous current machine which was running at one of the South Kensington Exhibitions, and when the difference of potential was measured between the places touched by the victim it was found to be 500 volts only. Again, deaths have occurred from alternating current Gramme machines supplying electrical energy to Jablochkoff candles, arranged on separate circuits of five each, the difference of potential necessary to keep the lights burning not exceeding 250 volts.

Telephonic commu-  
nication between  
London and Paris.

THE rumours which have been so long floating about in the air concerning this communication are gradually shaping themselves into something tangible. Already, we believe, considerable progress has been made on this side of the water with reference to the matter, materials having been got in hand for the purpose, and we believe that what delay is taking place is wholly due

to the authorities on the French side. The French Chamber has now, however, unanimously voted the expenditure of 400,000 francs towards the expense of establishing the telephonic line, and we may, therefore, expect rapid progress to be made. Of the possibility of working between the two capitals there can be no doubt, it is simply a matter of proportioning the dimensions of the cable cores and the aerial conductors, so as to bring the "KR" well within the value that it is known will give clear speaking, and this will be attainable without having them of very unusual size.

THERE has not been a great rush on the part of the clergy and parishioners of the various churches to have the electric light installed in these sacred precincts. Of course, many reasons could be given for this. It would seem, perhaps, inadvisable to erect special plant, but in the case of a church or place of worship being in the neighbourhood of a central station, the question is a simple one. This, no doubt, has influenced the vicar and churchwardens of St. Jude, Kensington, who have concluded arrangements with the House-to-House Company, as notified in another column.

Cable Laying made  
Easy.

THE *Bootle Times* has a remarkable contributor to its columns, and his articles on "Submarine Navigation" have been reprinted in pamphlet form. We do not think that this literary giant has even a method in his madness, as witness the following plan for utilising submarine boats in cable laying operations:—"The saving in time and cost of laying deep-sea electric cables, if these cables were guided to their resting place by a submarine vessel, would pay over and over again for the cost of the boat, and we should hear very little of disconnections and fractures in mid-ocean. The indirect gain would doubtless be much greater than even the saving in cost of surveying, laying, and subsequent repairs."

The Compound  
Winding Case.

IT is with regret that we learn of the intention of the Brush Electrical Engineering Company to appeal to the House of Lords against the judgment in the Scotch Courts. We can scarcely hope that the electrical trades will make any effort to resist the application of the company, because it is probably thought that even if the appeal is successful they have not much to lose considering that the duration of Brush's patent is nearly at an end; however, it must not be forgotten that there may be such an infliction as the payment of back royalties. We would gladly see some friendly pressure brought to bear upon the company, for after being fairly and squarely beaten on two occasions the present intimation looks too much like the last throw of the gamester, and people may be apt to think that there are other motives than the mere desire to sustain Brush's patent to account for the attitude which the company has seen fit to adopt; indeed, it seems possible that financial considerations may have had considerable weight in bringing the directors to their decision. Mr. Varley has on another page again drawn attention to this matter, but as the above remarks were penned before his copy reached us, we do not hold ourselves in the least degree responsible for his utterances, which must naturally be of a partial character.

## FIELD'S MERCURY THERMAL CUT-OUT.

THE protection of telegraph and telephone apparatus from abnormal currents, says the *Electrical Engineer*, New York, has led to the construction of a large number of cut-outs, both electro-magnet and thermal in their nature. In order to avoid the introduction of an electro-magnetic device which might introduce retardation, and, on the other hand, to overcome the objection to lack of uniformity and fragility in fine fuse wires, Mr. Stephen D. Field has recently invented an ingenious cut-out in which mercury is employed as the fusible, or rather volatile, material. Another object aimed at is to obtain such a construction that upon the cessation of the abnormal current the circuit to the instrument is automatically restored without the replacement of any material in the cut-out.

The simplest form of Mr. Field's cut-out is illustrated in the accompanying engraving, fig. 1. It consists merely of a glass tube with a fine bore, which is filled with mercury, and has two conducting wires sealed in at the ends. The passage of an abnormal current heats the mercury, vaporises it, and the pressure generated bursts the tube, thus rupturing the circuit.

In order to provide for the automatic closing of the circuit above referred to, the construction shown in fig. 2 is employed. Here a chamber is placed at one end of the tube, which is part filled with the mercury. The air, which occupies a portion of the chamber, being an elastic medium, allows the expansion due to the vaporisation of the mercury in the capillary portion to take place without rupturing the structure, as the air becomes compressed and the separation of the column of mercury in the capillary tube can take place, thus opening the circuit in a reliable manner without destroying the apparatus.



FIGS. 1, 2, 3.

Another form of cut-out, shown in fig. 3, is similar to that shown in fig. 2, except that instead of leaving an open air-space in the chamber, a rubber ball filled with air is placed in it and the chamber completely filled with mercury. This prevents the escape of the air from the chamber into the capillary tube in transporting or handling the apparatus, while affording a sufficiently elastic medium to preserve the apparatus from destruction by the vapour-pressure generated in its operation.

Among the practical advantages claimed by Mr. Field for this form of cut-out, are first, that, if using only pure distilled mercury, it is possible to have absolute uniformity in the conductivity of a given size of cut-out. Again, the construction of capillary tubes of glass has reached such a stage of perfection that it is entirely practicable to have a given diameter uniformly reproduced; and, furthermore, the diameter may be very much smaller than it is possible to draw any of the known fusible wire metals or alloys. Again, mercury has a very high coefficient of resistance. It therefore becomes possible and entirely practicable to construct thermal cut-outs of this character so as to permit an exceedingly small fraction of an ampère to volatilise the mercury at the point of least diameter, and the

action will take place invariably at the same critical temperature. We have seen the cut-out in operation, and it seems to fulfil all the claims made for it by Mr. Field.

## NEW CABLE RAILWAY.

A NEW cable railway, in which electricity takes an important part, has been opened on the Monte San Salvatore, in Switzerland. The line commences a few yards above the level of the Lake of Lugano, with a gradient of 17 per cent., crosses the cutting of the Gothard railway by means of light iron bridges, and reaches the middle station at Pazzallo, with a gradient of 38 per cent. in 540 yards. The working plant is installed at this station, from which the second stretch of single line is continued to the summit of the mountain. This portion of the line begins with curves of 325 to 433 yards radius, with a gradient of 38 per cent., and terminates 26 yards below the summit. The total length of the railway, which is of one metre gauge, is just over one mile. In the middle of the track is a double rack rail on the Abt system. Two passenger cars run on the railway in such a manner that when the one on the lower portion is ascending, the other on the upper line is descending.

The track rails are bolted to sleepers laid on a masonry foundation. The cable consists of a cast steel wire rope  $1\frac{1}{2}$ -inch diameter, running over grooved pulleys at the working middle station. Throughout the whole length of the line the cable is supported at intervals of from 13 to 16 yards by means of rollers hollowed in the middle. These rollers are 16 inches long and 8 inches in their smallest diameter. Larger rollers, made of iron and lagged with wood, are used round curves in order that the bite of the cable may be increased. Each car weighs  $4\frac{1}{2}$  tons, and contains four compartments, accommodating, in all, 32 passengers. The cable is attached to the underside of the car on one side. Each of the two axles to each car has fixed to it two rack wheels which engage with the before-mentioned rack when the car is in motion. Fixed on each axle are two brake pulleys, which are connected by means of two chains with two pairs of brake blocks. One of these brakes is connected with a crank lever on the driving platform by a shaft and suitable gearing, whilst the other three brakes are automatically applied if the cable becomes slack or breaks. The latter can also be worked by the driver pushing a lever with his foot. When either the hand or automatic brakes are used, they are applied to the axles of the car, thus preventing their revolving, whilst the rack wheels keep the car in a stationary position.

The working station at Pazzallo contains a 40 H.P. motor, series wound, running at 700 revolutions a minute. A 50 H.P. portable boiler and engine is provided as reserve, in case of repairs being made at the water-power station, or if a breakdown should take place. The motor or engine, as the case may be, drives, by means of belting, a countershaft, running at 138 revolutions. On this countershaft are fixed two bevel wheels and two friction wheels. A second countershaft, placed at right angles to the first, has arranged at one end a bevel wheel, which engages with either the one or the other of the two bevel wheels on the first shaft, and causes the second shaft to revolve in either direction as desired. There is also provided a third shaft, upon which the large driving pulleys revolve. The second shaft carries two brakes, one being for hand regulation, and the other being applied automatically when the cars are at the middle station, by the vehicles pushing over two levers. The working station is in charge of an engineer, who operates the hand brake and a regulating wire resistance, whilst an ammeter at the upper station controls the current. The two termini and the middle station are connected by telephone, and the latter is also in telephonic communication with the power station at Maroggia. Elec-

tric bells serve to announce the arrival and departure from the termini to the middle station, and *vice versa*. Throughout the whole length of the railway is arranged, almost in contact with the outside roof, an electric conductor which, on the driver moving a switch, closes a circuit. This contrivance permits of signals for backward or forward movement of the car being transmitted to the engineer at the working station.

The power for operating the railway is obtained from a fall of water, which is led down an iron tube 20 inches in diameter, and 370 yards long. The available power is estimated at 700 H.P., and the lower end of the tube terminates at the generating station, which is situated near the Maroggia station at the south end of the Lake of Lugano. At present the water-power is only used to actuate two Girard turbines having horizontal axes, and driving two Oerlikon dynamos direct. One of these dynamos is a continuous current machine, and the other an alternator having its exciter placed on the same spindle. The continuous current dynamo is used for transmitting the power, whilst the current from the alternator is, by the intermediary of transformers, used for lighting the town of Lugano and the cable railway stations. The alternator, which runs at 600 revolutions at an E.M.F. of 2,000 volts, supplies current to 1,500 16-C.P. lamps, which are installed in the local hotels, restaurants, &c. The price for light is  $\frac{1}{4}$ d. per lamp hour.

The continuous current dynamo is series wound, runs at 700 revolutions, and has an output of 22 amperes at 1,800 volts. The machine has been built for delivering 60 H.P., and is automatically prevented from being overloaded. The current from this dynamo is led to the motor at the Pazzallo station by 5 mm. copper wires arranged on the two-wire system, and carried on oil insulators placed on poles. The loss in E.M.F. at full load amounts to  $16\frac{2}{3}$  per cent. Thus the motor receives 22 amperes at 1,500 volts, this giving an output of the motor of 40 H.P. and an efficiency of 66 per cent. The distance from the generating station to the motor is about five miles. Suitable regulating apparatus is provided at the Pazzallo station. On ordinary days there are four journeys up the mountain and four downwards, but on feast days and at holiday time the cars make 24 journeys. The time occupied in transit from one terminus to the other—the speed being one metre per second—is about 30 minutes. The fare is 2s. 6d. for the up, and 1s. 3d. for the down trip, or 3s. 3d. there and back; on holidays these charges are reduced by half. The total cost of the installation, exclusive of conductors and turbines, has been £24,000. The undertaking has been carried out by Messrs. Bucher and Durrer, of Kägiswyl, and the railway was opened a few weeks ago.

#### THE NICHOLS PATENT LAMP HOLDER.

MOST of our readers must have often remarked on the clumsy appearance given to arc and other electric lamps which required to be lowered to replace the carbons, or for cleaning, by the long loose loop of cable

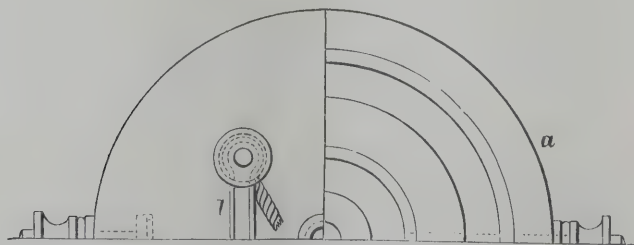


FIG. 1.

hanging at the side, as illustrated in fig. 4, the dotted position showing the lamp lowered for adjustment and the upper position showing it when working.

The necessity for this slack cable may be entirely avoided by the use of Nichols patent lamp holder, which we illustrate in figs. 1, 2, 3. Fig. 1 being a half plan, one quadrant showing the terminal and the other

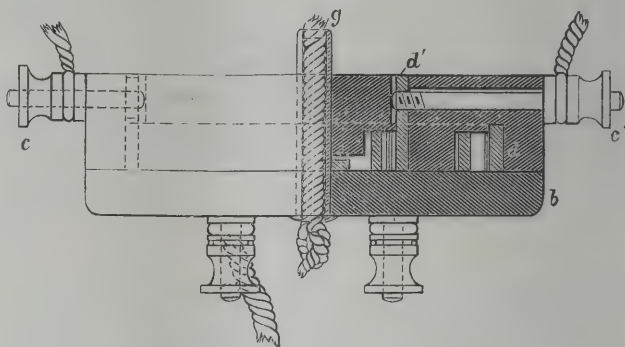


FIG. 2.

showing the inner face. Fig. 2 is an elevation half in section, and fig. 3 a plan of the inner face of the lower half. The holder consists of two parts, *a* and *b*, made of slate or other non-conducting material, the part *a* is to

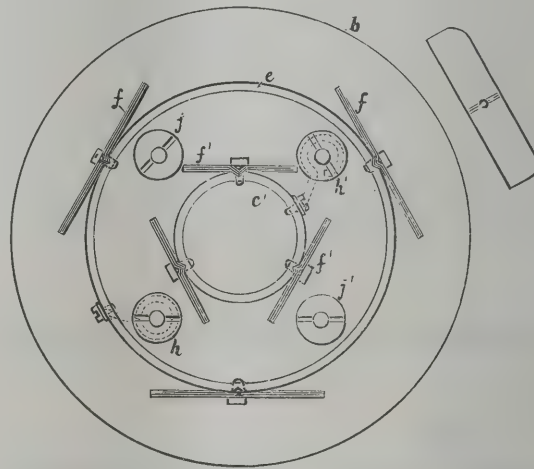


FIG. 3.

be fixed to the ceiling or roof from which the lamp hangs, and the part *b* carries the terminals to which the lamp is attached.

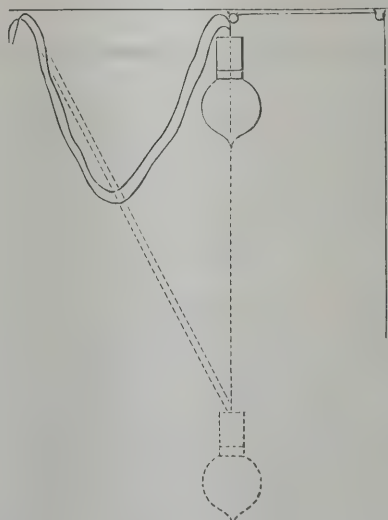


FIG. 4.

The part *a* is provided with two terminals, *c* and *c'*, to which the main leads are attached and each terminal is connected to a gun metal ring, the terminal *c* to the

outer ring  $d$ , and  $c'$  to the inner ring  $d'$ . The part  $b$  is, as will be most clearly seen in fig. 3, provided with two rings,  $e$  and  $e'$ , each fitted with contact plates,  $f$  and  $f'$ , made of thin sheet copper or gun metal which make connection with the rings,  $d$  and  $d'$ , of the part  $a$  when by means of the cord,  $g$ , the part  $b$  is drawn up. Each ring,  $e$  and  $e'$ , is in electrical connection with one of the terminals,  $h$  and  $h'$ , and between the terminal  $h$  and that marked  $j$  is fixed a fuse,  $l$ , fig. 1. The terminal  $h'$  is connected to  $j'$  by suitable wire and the lamp hung from the terminals,  $j$  and  $j'$ , three binding screws may be used instead of four, obviously, if so wished. An

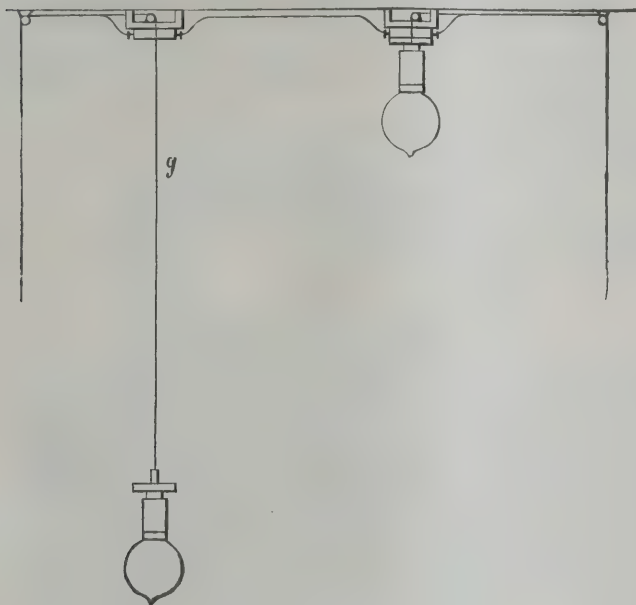


FIG. 5.

arc lamp or incandescent lamp of the Sunbeam type can be hung as illustrated in fig. 5, which shows one lamp lowered by means of the cord,  $g$ , and the other drawn up into position. The cord passes over small pulleys and can be fixed in any convenient position on the wall within reach of the hand. Where these holders are used in series a switch is provided upon the fixed part  $a$  which automatically completes the circuit when the lamp is lowered.

Several of these holders are now in use in the Leeds Town Hall and municipal offices where they have given every satisfaction. We are informed that Mr. E. R. Dolby, of 8, Princes Street, Westminster, is prepared to supply any further information.

### THE REICHENHALL CENTRAL STATION.

IN May last there was opened at Reichenhall a central station which, for town lighting by transformers, is considered by the *Elektrotechnische Zeitschrift* to be very large. The necessary power is obtained from a mill brook, which is supplied with water from a weir erected in the river Saalach. The length of the brook is about 350 yards, having a fall of nearly 9 feet, and the available water amounts to from 880 to 990 gallons per second. This water actuates a Jonval turbine, yielding, at an efficiency of 75 per cent., from 106 to 120 H.P. It runs at 34.5 revolutions a minute, and transmits power, by means of toothed wheels, to a horizontal shaft which makes 121 revolutions. This shaft carries a pulley, over which passes a belt which drives an Oerlikon alternator at 600 revolutions. The current furnished by this machine is 30 ampères, at 2,000 volts, and the exciting dynamo is mounted on the shaft of the alternator. The current is led by insulated conductors to the switchboard, and the exciting dynamo energises the lamps in the generating room, with the exception of one placed on the switchboard, and which is fed from a small transformer.

The primary current is led overhead through Reichenhall to the St. Zeno Convent, a distance of nearly two miles; and then, further away, to Kirchberg, and several other localities. The aerial conductors consist of two copper wires of 6 mm. cross section, insulated by Johnson and Phillips oil insulators, and carried on masts 49 feet high. At present there are ten transformers used, arranged in parallel. Two of these are for 10,000 watts, six for 5,000, and the remaining two for 1,500 watts. The secondary current is distributed at two distinct tensions: at 100 volts for glow lamps, of which 900 are now installed, and at 50 volts for 118 arc lights. The total loss in the primary conductors is said to be 3 per cent. The installation has been carried out by the Munich depôt of the General Electrical Company of Berlin.

### PROF. THOMSON'S LATEST DYNAMO.\*

THE accompanying cut shows the details of a dynamo-electric machine so extraordinary in its structure and electrical properties as to be fairly revolutionary; a machine quite as unique in its way as the Duncan motor, to which reference was recently made in our editorial and other columns. The new machine is the invention of Prof. Elihu Thomson, and its special marked properties are total absence of external magnetic field, and almost complete freedom from hysteresis.

Fig. 1 shows a section of the machine. The revolving portion of it consists of a shaft surrounded by a massive iron cylinder, bearing on its central portion the laminated mass of iron that forms the internal pole

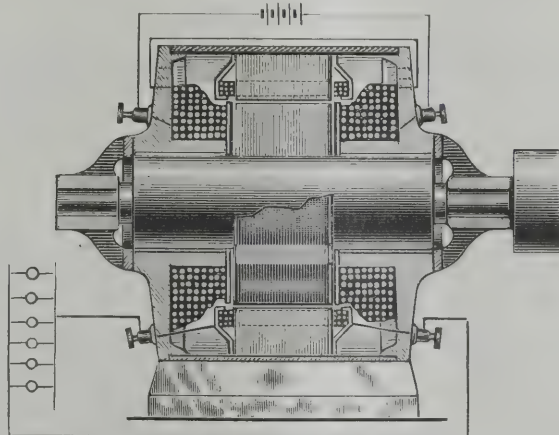


FIG. 1.

pieces. The appearance of this part of the machine is shown by fig. 3. This iron mass revolves within a pair of iron sleeves, which carry the bearings of the machine and the magnetising coils, which are thus fixed and wound on bobbins on either side of the revolving poles. The end plates of these massive sleeves are joined by a cylindrical casing of iron, completely shutting in the machine. On the interior of this casing, and immediately surrounding the revolving pole pieces, is a ring with inwardly pointing poles barely clearing the revolving ones. Looped around these poles are the armature coils. The magnetising coils of the machine are so wound as to produce, in the revolving portion, consequent poles of the same polarity in each of the polar projections. The magnetic circuit extends through the internal cylinder and its surrounding sleeves through the outer casing, and forms consequent poles of opposite polarity to the revolving ones in the polar projections that point inward. There is thus no external field whatever.

The action of the machine is as follows: The moving field poles carried around by the revolution of the core piece pass in front of the coils in which the currents

\* *Electrical World.*

are to be induced. The lines of magnetic force from these pole pieces cut transversely across the wires on the coils, since these lie in the proper direction to be so cut, or at least the sides of the coils parallel to the axis so lie, and in them are generated impulses of current. The direction of the winding and connection is such as to make the effect accumulative in the coils, so that if the polar projection passes (as in fig. 2) over the centre of one coil to that of the next, its lines of force are

FIG. 2.

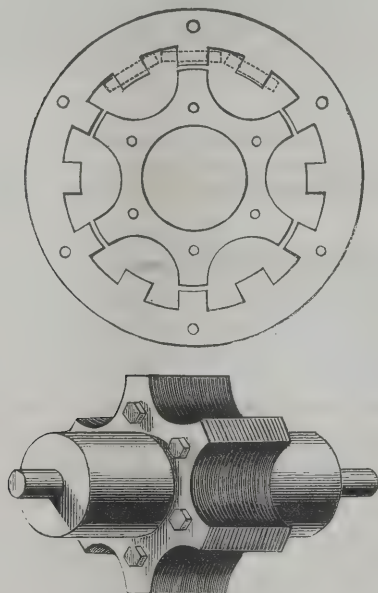


FIG. 3.

caused to cut the wire lying between these centres. Impulses of current would thus be set up in both coils, and as the coils are wound each impulse will be super-added. The number of inward pointing poles may be, as in this case, double that of the outward pointing poles; or it may be the same, when the action becomes a simple cutting in succession by the lines of force emanating from the polar projection, of one side of a coil, or of one side of all the coils taken together, and immediately afterward the other side of the same coil or set of coils.

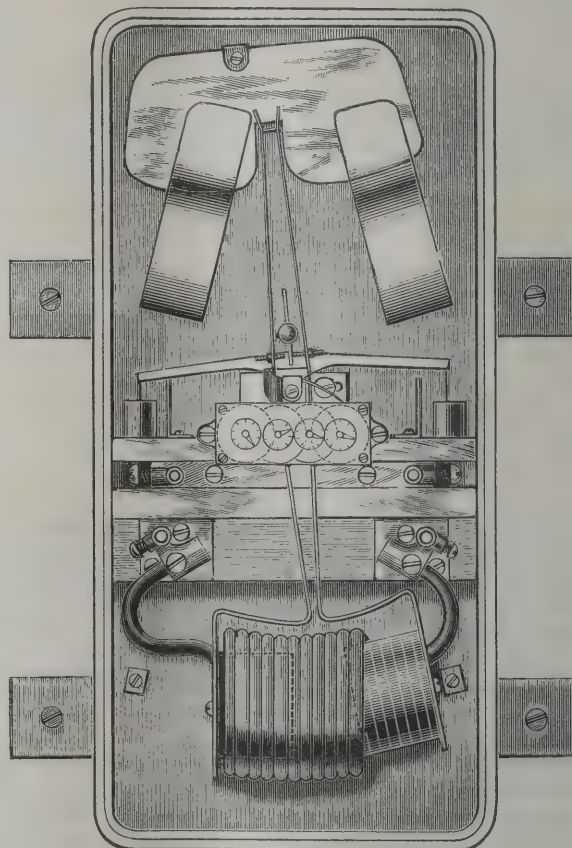
These actions will be repeated in the coils every time a polar projection passes the wire on either side of the coil, so that if there be six poles, and the revolution of the machine be at the rate of 1,000 turns per minute, there would be 6,000 complete alterations of current per minute. These actions of induction will be accomplished without reversal of magnetism in the core piece, or in the laminated ring structure supporting the coils, and hysteresis will thus be reduced to a low amount. Of course, all cannot be obviated, for the reason that there is a changing of the magnetism of the pole pieces in any case; but it will be reduced to a quantity far less than if the same mass of iron were reversed as usual. It is not necessary then to laminate either the revolving or the stationary poles, and it is obvious that the machine, although described as a dynamo, is equally applicable to the construction of an alternating motor that would possess many desirable qualities; or, by the addition of a commutator, be suited to the production of continuous currents.

We think that this description is sufficient to indicate the remarkable properties of the new machine, and although as yet no details of its efficiency are at hand, it certainly appears to be a very simple and effective form of generator or motor. The construction is especially easy and the winding admirable, since there are no moving coils, and therefore no moving contact of any sort, the wires to both field and armature being simply connected to binding posts. The machine certainly is very creditable to Prof. Thomson's inventive genius, and, unless we much mistake, will soon be heard of commercially.

### PROF. THOMSON'S ELECTRIC METER.

A VERY ingenious application of Prof. Thomson's beautiful experiments in electro-magnetic repulsion by alternating current, says the *Electrical World*, is to be found in his electric meter, of which a cut is given herewith. It is an exceedingly simple contrivance, and is as effective practically as it is neat theoretically.

This meter is a modified form of the motor type that measures the current by its direct electro-dynamic action, but, as will be seen, possesses some rather interesting peculiarities. Like most similar devices, it registers the readings directly upon dials like a gas-meter, and can consequently be read by the consumer at any time. This is no small convenience, although perhaps somewhat overestimated, for it is no guarantee of accuracy.



The arrangement consists, as shown, of a single coil of coarse wire wound along a gentle arc. This carries the main current to be measured. Immediately above it is a pendulum, mounted on knife edges, and provided at its lower edges with a pair of coils of fine wire, which are swung inside the solenoid just mentioned. The pendulum is prolonged above the knife edges, and bears at its upper extremity a light copper sheet, which swings in the magnetic field produced by the permanent magnets shown. This delicately poised pendulum is provided with the apparatus intended for registering its oscillations on the dials. The motive power is the repulsive force produced by the solenoid on the two fine coils of the pendulum. These are alternately connected as high resistance shunts across the mains of supply. The main current is thus forced through the actuating solenoid, while a derived current of small quantity energises alternately the two coils on the pendulum bob, being shifted from one to the other at the extremity of the swing by means of the commutator attached near the knife edges of the pendulum. Thus when current is turned on the meter a steady air line is set up, damped considerably by the currents induced in the copper sheet at the upper extremity of the pendulum and checked at either end of the swing by elastic stops. The possibility of using the apparatus as an energy meter is obvious, and altogether it seems

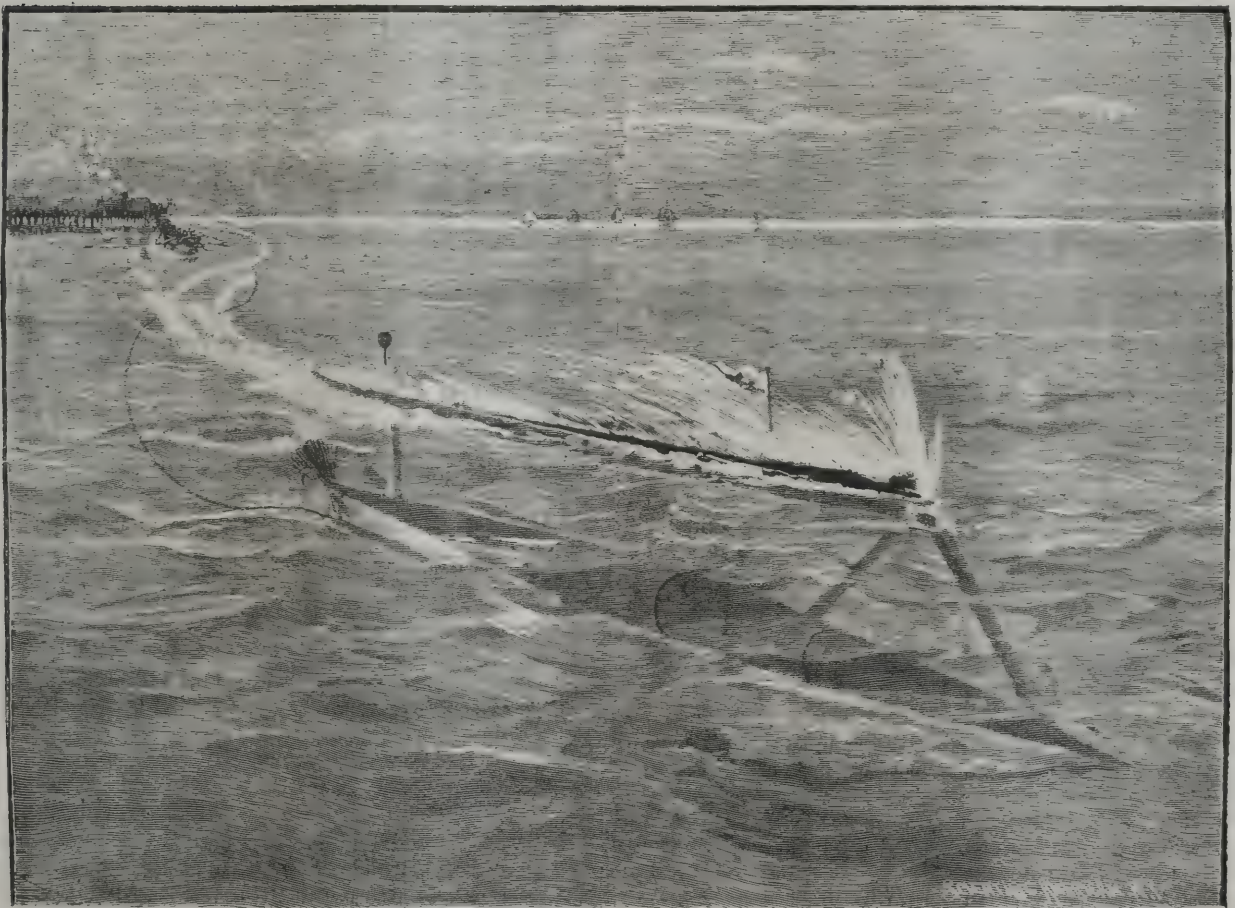
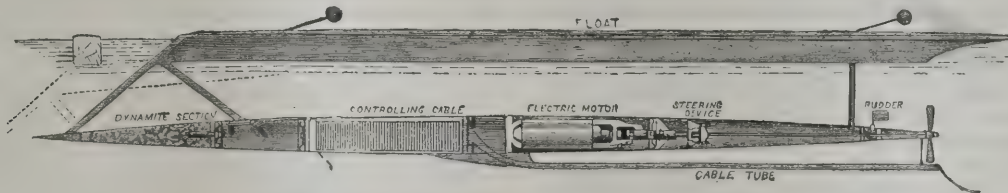
a very finished and simple apparatus for registering the amount of current passing through. It is obvious enough that slight modifications will enable it to be used for measuring continuous currents also.

### EXPERIMENTS WITH THE SIMS-EDISON TORPEDO.

ON Tuesday, July 15th, an exhibition of the Sims-Edison electric torpedo was given at Willetts Point, at the entrance of Long Island Sound, in the presence of

filled with cellulose or cork, in order to resist the effects of penetration by shot. In actual trial it has been found to be a very difficult object to hit. The cable is connected to a dynamo at the station, which may be on the shore or in a ship.

The peculiarities of its action as developed by these features may be summarised thus: As the torpedo progresses the cable is fed from out its body. The result of this is that there is no cable to be dragged through the water; the torpedo progresses, but the cable remains stationary, so as not to impede its speed. As the source of electric power is in the station, there is no limit beyond that imposed by the size of the cable and electric motor to the power which may be



a numerous gathering of representative naval and army men and other guests. We (*Scientific American*) have already described and illustrated the general features of the torpedo in this paper, and we reproduce our sectional view of the same in order to recall to our readers' mind its general construction. It consists of a cigar-shaped torpedo and motor case, within which is stowed away upon a reel from one to two miles of controlling cable. The cable is led out through a tube running parallel with the axis of the torpedo and boat to a point aft of and below the propeller wheel. Above the torpedo proper, and rigidly connected thereto, is a float possessing the general outlines of a racing shell, and provided with two sighting poles by which its course can be observed. The hull, if desired, can be

transmitted. The active explosive agent is contained in the submerged torpedo case, and in advance of the bow of the float. It, therefore, is the first portion to come in contact with the hull of a ship. The instant it touches the hull the motion of the craft will be arrested, and the electric instruments on shore will at once testify to such arrest of its course by the increased mechanical strain put upon the motor, which would at once affect the current. Finally the raking bow connection, which is seen in the illustrations, enables it to give under obstacles. This manœuvre has been subjected to a severe test, and the action of the torpedo in this way has been found to be very perfect.

As it was exhibited on Tuesday, it was worked from a shore station as shown. The torpedo was lowered

in the water and the current turned on from the switch-board. At once the craft started into action, and at a rapidly increasing rate of speed ran out into the stream. Before it stopped it had completed its course of about a mile. Under complete control of the operator on shore, it emerged from the station, and describing a long and circuitous route in the water, returned nearly to its starting point. The mile of distance was completed in about three minutes, indicating the attainment of a very high rate of speed. When in full action the hull became nearly buried, while quite a wave was thrown from the rapidly advancing bow. In some observations it has been noted that the boat went so fast as to run away from the wave it generated. All through its course triangulation observations were taken at exact intervals, in order to determine its speed. These were in charge of the corps of engineers attached to Willets Point.

The torpedo is built in four sections, which can be taken apart or assembled in 15 minutes; none of the parts weighs more than 500 pounds. The motor at full speed can absorb over 30 horse-power available for propulsion. A speed of 22 miles an hour has been obtained by it. The charge of 250 to 500 lb. of high explosive is to be exploded electrically by reversing the current. The steering is also done electrically through the agency of a polarised relay.

Its operation from a shore station is limited in extent by the length of the connecting cable. In the large torpedoes this will be two miles. In operation from a war ship, it is proposed to run two or more boats along a parallel course with the ship and close to it, receiving their motive power from the ship's electric plant. Here, as the ship and torpedoes will all progress alike, and as the electric plant on board can supply power for an indefinite period, the ship and torpedoes can keep company for almost any number of miles. When the enemy is approached the course of the ship can be arrested or its speed can be slackened, and the torpedo sent ahead or to either side at high speed, in order to destroy the enemy. For fort use a special form of casemate with conning tower and other necessary features have been planned by the company. There is little question that a number of these torpedoes could do much to defend New York harbour, at the end of the East River, between Willets Point and Fort Schuyler, and at the Narrows, from entrance by hostile vessels.

## THE ELECTRIC RESISTANCE OF GAS IN MAGNETIC FIELDS.

MY primary investigations with the action of magnetic fields upon Geissler tubes, the results of which I had the honour to place before the Academy, at the sitting of the 12th May, 1890, had yet, writes M. A. Witz (*Comptes Rendus*), to be completed; in fact, when the effects produced by varying the intensity of the field, and the position of the tube in relation to the field's lines of force had been studied, it still remained to determine the influence which a modification of the gas pressure within the tube would exercise.

My experiments were made with the aid of a glass cylinder, 2 cms. in diameter, fitted with taps, and as well adapted for compression of gas as for rarefaction; the discharge took place between two electrodes, the cones of which were aluminium. With mercury pressure, 0 cm. 6, I obtained a violet tinted discharge; at 230 cm. the result was a spark, warm, brilliant, and sustained, in the form of a flash of fire between the points; and between these two pressures the appearances were a combination of spark and discharge. Now the action of the field, as presented to the eye, varies under these different conditions; the discharge is subject to deviation in obedience to the electrodynamic laws—the spark is not; consequently, when the pressure is slight, the action should be considerable; when with a high pressure it would be *nil*.

We have now to verify the exactness of these inferences, and the following are the results obtained:—

### Outside the Field.

Pressure.	Current.	Difference of potential.
cm.	milliampères.	volts.
0.607	5.86	976
32.446	4.66	2,815
74.610	2.79	4,669
76.029	3.50	5,544
114.310	2.33	8,058
115.51	2.16	8,731
230.1	1.42	12,028

### In a Field of 7,200 Units.

Current.	Difference of potential.
milliampères.	volts.
3.91	9,787
2.75	5,857
2.04	4,719
2.05	6,919
1.44	8,097
1.27	9,487
0.74	12,539

With the slight pressure 0 cm. 6, the difference in potential was ten times greater; whereas at 3 kg. pressure the variation was, so to speak, *nil*. From this I feel justified in concluding that it is only upon the electric discharge that the fields have any influence at all.

This, which with the Geissler tube is so considerable, must then be a peculiarity of the constitution of this tube and of the rarefied condition of the gas which it encloses, since it is not to be produced with free gases unconfined.

This should result in a previous indication for the analysis of the complex phenomena observable in the Geissler tubes. The similarity between the effects produced with a magnet and by the approach of a metal conductor (nay, by approaching the finger even) leads me to a fresh explanation of these phenomena. The similarity is striking, judged by one example. Thus a tube enclosing silicic fluoride gave the following results:—

### Outside the Field.

Current.	Difference of potential.
1.50 milliampères.	2,434 volts.

### In proximity with a mass of Iron.

Current.	Difference of potential.
1.16 milliampères.	3,185 volts.

### In a field of 11,570 Units.

Current.	Difference of potential.
0.99 milliampères.	5,730 volts.

It is true the effects varied with the nature of the gas, the form of the tube, pressure, &c., but they were almost always remarked in connection with tubes of sensitive condition. The phenomenon was sufficiently general to allow of the action of the magnets being attributed to a varying in the electric capacity of the Geissler tubes. These tubes must constitute, therefore, genuine condensers, and their illumination should be the result of an oscillatory discharge of a nature similar to that of a Leyden jar, the period,  $T$ , of which is the function of the jar's capacity,  $C$ , and of the coefficient,  $L$ , of the conductor's self-induction, the resistance of which is assumed to be slight, since  $T = \pi \sqrt{LC}$ . A varying of the capacity,  $C$ , would, consequently have the effect of modifying the vibratory condition of the gas, and be the occasion of the differences observable in the luminous phenomena of intense magnetic fields.

**Lincoln and Electric Lighting.**—The Town Council has refused to grant consent to any electric company wishing to supply the light.

## ELECTROLYTIC THEORIES.\*

By Prof. G. F. FITZGERALD, F.R.S.

ELECTROLYSIS has been explained on two different theories by Grotthius and Clausius. As generally received they differ. Grotthius's theory, as generally given, assumes that the molecules in an electrolyte are both polarised and moved by the electric forces within the liquid. This seems so far untenable that it would appear that double the electric force would double both the polarisation and the motion of the molecules, and so should produce four times the electrolysis. The objection, however, assumes that we know the causes resisting the motion, and with proper, and not very improbable assumptions as to the resistance to motion depending on it and on the polarisation, a linear relation between current and electromotive force, *i.e.*, obedience to Ohm's law, seems possible. A modification of Grotthius's hypothesis in the direction of Clausius's is, however, possible. Suppose that when polarised the molecules *drew one another apart* at a rate proportional to the polarisation. This at once makes the relation between electric force and the decomposition a linear one, and so satisfies Ohm's law in the case of small currents. It also so far agrees with Clausius's hypothesis that it explains electrolysis and double decomposition as properties of the same kind. The molecules in a liquid will occasionally be arranged by accident in the proper polarised condition in a closed circuit for drawing one another apart; and if the circuit includes molecules of different kinds, there will result double decomposition. There seem to be very serious difficulties in supposing that uncombined atoms are for any finite time free in the liquid; and the supposition that it is a particular arrangement that is required before exchanges take place, and that with this arrangement exchanges take place of their own accord, seems to explain electrolysis and double decomposition without supposing free atoms to exist within the liquid. I have not assumed Prof. Armstrong's suggestion that the proper arrangement for double decomposition is a double molecule; but it seems a likely hypothesis, and one that should be investigated from the chemical rather than the physical side.

There are some other phenomena that have been explained upon the supposition that free atoms are gadding about in a liquid. Such are the lowering of the boiling and freezing points by solution of salts, and their effect on osmotic pressure. If dissociated atoms are going about in a liquid as in a gas, it seems impossible but that they must diffuse at different rates; and that this is not observed seems conclusive against the hypothesis, no matter what else the hypothesis may explain. Consider solution simply. Why does chloride of sodium dissolve in water? There must be some strong affinity between the two of a chemical or semi-chemical nature to break up the cohesion of the crystal; and it seems reasonable to assume that this same affinity keeps the molecules of NaCl moving about among the water molecules, so that they diffuse about. Now, if the forces drawing them about be independent of the nature of the molecule, most of the phenomena explained by gaseous laws are explained. Pressure of a gas depends, at any temperature, on the number of molecules, and not on their kind. This is Avogadro's law, by which molecular weights are calculated; and if the forces drawing a molecule about in a liquid are independent of the kind of molecule, the very same law of pressure would hold, the pressure forward of molecules of different kinds would depend on their number only, and in the same way as Avogadro's law would enable molecular weights to be calculated. In this connection it is well to state that some bodies may, nevertheless, be much better able to produce pressure than others, because of their being more easily polarised, *i.e.*, turned into an effective direction. A molecule

which could be easily turned into an effective direction would be about twice as effective as a molecule which went about in a higgledy-piggledy way; and one would consequently expect electrolytes to produce more, nearly double, the osmotic pressure that other bodies did. As to the changes of boiling and freezing points, they seem explicable by exactly the same hypothesis. The reduction of vapour pressure by molecular affinity of dissolved salt would depend only on the number of molecules of salt if all salts have the same molecular affinity for water; and the same would apply to the change in freezing point. Hence all these phenomena are explained without assuming free atoms and they are all explained by what can hardly avoid being a *vera causa*, namely, whatever affinities they are that cause solution, which latter is an unexplained phenomenon on the dissociation hypothesis. That it is reasonable to think that the forces keeping the molecules of salt moving about in the water are independent of the nature of the salt, appears from various considerations. In the first place, these forces are in all probability due to the residual affinities of the non-metallic elements. These same forces are probably the cause of crystallisation. These are old suggestions. That these residual affinities should be nearly the same for different combinations does not seem at all unlikely.

If a rather shaky argument in favour of its likelihood on mechanical grounds is desired, the following may deserve attention. Suppose a molecule of NaCl, for instance, at rest, or nearly so, in a crystal. Subject it to this affinity. Its velocity, after it has gone a distance,  $s$ , will be given by some such relation as  $fs = \frac{1}{2}mv^2$ . Now, for the sake of temperature equilibrium, with molecules of somewhat similar structure,  $\frac{1}{2}mv^2$  must be the same in all. It seems likely that, at least approximately, the kinetic energy of motion is proportional to the total energy, and that this is the same for each molecular group; if so, the kinetic energy must be approximately the same for different groups. Now, with very dilute solutions  $s$  must be nearly the same for different molecules, and if so we get that for temperature equilibrium  $f$  must be independent of the nature of the molecule. How this equalisation of  $f$  for different kinds of molecules comes about may be as follows. Molecules in a liquid move about among one another, but are well within the sphere of one another's attraction, as is evidenced by superficial tension and by the tension to which a liquid can be subject. A very small change in the distance apart of the molecules means, however, a very great change in the forces between them, as otherwise they would be extensible and compressible like gases. It seems likely, then, that when a salt dissolves in a liquid it requires for temperature equilibrium that the distances of the molecules should change by the very small amount required in order that  $f$  may become the same for all substances. This very minute change in distance would not sensibly affect  $s$ .

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**Electrical Indicator of Explosive Gases.**—An apparatus which indicates with safety the accumulation of explosive gases in the atmosphere of rooms is of great importance in many trades, and especially for use in mining operations and in the transport of coal by ships. M. Eduard Stern, of Cologne, has brought out such an apparatus. It consists of an external porous clay cylinder which contains a thin metal membrane capable of upward movement. Just above the membrane is a contact screw. When explosive gases begin to accumulate, they pass through the porous cylinder and gradually raise the membrane until it comes into contact with the screw. This completes an electric circuit and sets in operation a set of electric bells. The contact screw is very sensitive and may be adjusted to any degree, according to local circumstances. The apparatus is also applicable as a fire alarm and may be fitted in any convenient spot.

\* Communicated by the Secretaries of the Electrolysis Committee of the British Association.

## THE DYNAMO AS A MOTOR.

THE easy convertibility of a generator into an efficient motor was demonstrated lately in a very satisfactory manner at the Manningham Silk Mills of Messrs. Lister & Co., Limited, Bradford. During the recent overhauling of one of the main engines, which worked the machines in the batting, shearing and finishing departments, it was found that repairs had to be made which would take up so much time that unless substituted power could be obtained these important departments would be stopped, and a number of hands would be idle. As no ordinary or ready means were available for this object it was suggested by the electrician to the firm, Mr. Edwin Preece, that the dynamo used for the lighting of this department should be tried as a motor in place of the engine under repair. Permission having been granted for this trial, the electrician, assisted by Messrs. Andrews and Preece, Limited, Borough Mills, Bradford, quickly made the necessary arrangements, and the dynamo was very shortly at work driving the shafting.

In an article which we published on June 20th, describing the installation at the Manningham Mills, it was pointed out that one portion of the mills was lighted by a "Preece" 500 ampère dynamo, driven by an independent Robey engine, whilst the other portion of the mill was lighted by a similar dynamo, driven by a clutch arrangement from the main engine of the mill (which was the one broken down). The two systems of lighting were, as explained, connected together by mains governed at each switchboard by a double plug switch, with only one pair of plugs, in order to avoid confusion; but under the altered circumstances, it was necessary to connect up the plug switch at each board, consequently a second pair of plugs had to be obtained; the arrangement was then complete, after the ropes from the flywheel had been disconnected from the main driving pulley in the shaft. The Robey engine was started, driving the dynamo attached to it and generating a current which was transmitted to the second dynamo by means of the conducting wires and the double connection of the switchboards, the second dynamo then—its brushes being reversed—became a motor, and being clutched on to the main shafting by means of its own counter-shaft, produced sufficient power to work the various machines required in the department.

The whole arrangement was completed in about an hour after the decision had been arrived at, and the machinery was started without the slightest hitch whatever. The current passing into the motor varied from 250 to 500 ampères, according to the different loads, at a potential of 115 volts; it was kept running for about 36 hours without one single stop or the slightest interruption whatever. The remarkable self-regulation and regularity of speed under different loads, was an agreeable surprise to the principals of the firm, who were so well satisfied with the new arrangements that in all probability a further development of electricity as a motor may be decided upon. This is, we believe, one of the few instances where a dynamo has been utilised to take the place of the steam motor which usually drove it, and thus enable the operations of the factory to be carried on with but the slight delay due to the necessary alterations in connection. The whole operation reflects credit on those engaged, and demonstrates the extraordinary value of the dynamo-electric machine.

## KING, BROWN AND CO. v. THE ANGLO-AMERICAN BRUSH CORPORATION.

By S. ALFRED VARLEY.

FORMAL notice of appeal to the House of Lords in the above case has, I am informed, been given. The judgment lately delivered in the Court of Appeal not only confirms and strengthens that previously given in the

Court of Sessions, but is so clear and unambiguous that I cannot think it possible that the directors of the Brush Corporation will have the support of their shareholders, generally, in spending more money over litigation.

In November, 1887, the suit of *Brush v. Crompton* was compromised, judgment in favour of the plaintiffs being agreed to, and licences accepted, and the position of the Brush Corporation in respect to compound winding was consequently very much strengthened. At this stage I intervened, and, with a view to arousing the electrical industry to resist the claims so far successfully asserted, I tried the case, journalistically, through the medium of the columns of the *ELECTRICAL REVIEW*, in four consecutive articles which appeared in December, 1887. The following passage appears in the first article:—

"In my opinion, the electric light industry has so far allowed the Anglo-American Brush Corporation to simply walk over the course, and it seems to me the industry has acted most short-sightedly in doing so. It requires no prescience to foresee, that after the trade has acknowledged the claims asserted by the Brush Corporation, by submitting to pay royalties, that the next step will be to apply for a prolongation of the patent on the ground that this *valuable* invention, due to the *genius* of Brush, has yielded no returns commensurate with the expenditure incurred in developing it. And who shall blame them for making such an application, seeing that in the circumstances I have mentioned, it would most probably be successful?"

I also analysed and called attention to the very unsatisfactory character of the scientific evidence, and the publication of my articles resulted in Messrs. King, Brown & Co. resisting the Brush Corporation, and this firm, instead of waiting the convenience of the Anglo-Brush Corporation, took the initiative by themselves, commencing proceedings in the Scotch Courts, and after being successful in the preliminary skirmishes, on the advice of the Court, they took proceedings for the reduction of the Brush patent.

The case came on for hearing in the Court of Sessions, Edinburgh, in November, 1888, the Court deciding in favour of the pursuers, with expenses, and this judgment has been sustained on appeal.

In my opinion it is simply lamentable, and indicates a sad condition on the part of scientific professors, to see a physicist so distinguished as Sir William Thomson professing to be puzzled and not able to understand a plain simple description, which the judges had no difficulty whatever in comprehending, and doing so after *practical* evidence had been given before the Court by more than one unscientific mechanic and apprentice that they had experienced no difficulty in understanding the description given in my specification. The Court declared the description of compound winding given by Brush to be the same as that given in my specification, the only difference being that I had described it more simply. Now, Sir William Thomson and his brother professors did their best to persuade the Court that the description given in Brush's specification, in which compound winding was described as a "teaser," was as plain and understandable, as they declared mine to be incomprehensible.

Now, although there is scarcely any likelihood that the judgment given in the Scotch Courts will be reversed by the House of Lords, nevertheless, until it is disposed of, it will have a baneful influence on the industry, and therefore I would suggest that the industry should unite and draw up a pamphlet, giving a plain statement of the facts; that they should issue this pamphlet in their corporate capacity to the members of the Chamber of Commerce, to the members of the engineering and scientific societies, and also request the press to notice the matter contained in the pamphlet.

In this way, at a very small pecuniary cost, moral pressure would be brought to bear on the directors of the Brush Corporation, and the shareholders would, in all probability, oppose further useless waste of money on litigation.

## REVIEWS.

*Dictionnaire d'Electricité et de Magnétisme. Premier Fascicule, A—Electrolecteur.* Avec 284 figures. Par JULIEN LEFEVRE, Professeur à l'Ecole des Sciences de Nantes; avec la Collaboration d'Ingenieurs et d'Electriciens. Paris: J. B. Bailliére et Fils, 19, Rue Hautefeuille.

It is intended that this dictionary shall appear in four parts, the last to be issued before the end of the year. The complete set will form a volume of 1,100 pages, containing about 1,000 figures. Judging from the part now before us, the whole work, when complete, will be a very valuable addition to electrical literature, and will constantly be used for reference purposes. The value of the compilation would have been considerably increased had it been made more universal; thus, for example, under the first heading, viz., "Abonnement," we have full information given with reference to the subscriptions to the telephone exchanges in France, but nothing with reference to those in other countries. Of course, to have included the latter would have increased the size of the work, and it is probably this consideration which has limited its scope. The compilers have wisely made their descriptions fairly full, *i.e.*, have not sacrificed clearness to brevity; thus we have accumulators dealt with in nine closely printed pages, with several illustrations. The information given appears generally to be fairly accurate; here and there, however, we come across somewhat strange statements, as, for instance, when we are informed that to measure the insulation resistance of a cable the latter is placed in *acidulated* water; also, that submarine cables are wound upon great *drums* on the ships. Electric lighting is dealt with in 40 pages—Messrs. Woodhouse and Rawson's work coming in for a fair share of notice; considering the almost endless sources of information there are on this subject, and the consequent extreme difficulty of condensing the available matter, the selection made is very judicious and the scope wide. Altogether, the work creates a very favourable impression, although it is distinctly written (possibly not intentionally) from a French point of view.

*Journal of the Institution of Electrical Engineers,* No. 88. London: E. & F. N. Spon, 125, Strand.

This number contains the following:—Paper on "The Treatment, Regulation, and Control of Electric Supply by the Legislature and the Board of Trade," by Major P. Cardew, with discussions on the same.—Communication from Dr. Oliver Lodge in reference to damage to cables by lightning; this latter has reference to the suggestion that condensers and cables are never damaged by lightning, and professes to be testimony from Dr. A. Muirhead and Mr. Gott to the contrary; the testimony does not appear to be very conclusive as regards cables. The usual abstracts, &c., complete the number.

**Crystal Palace Engineering School.**—On Saturday last the certificates to successful students of the Crystal Palace School of Practical Engineering were distributed by Sir James N. Douglass, F.R.S., Engineer-in-Chief to the Corporation of the Trinity House. He referred in his address to the increasing attention given of late years in this country to technical education as a means of enabling young engineers to enter on equal terms the competition with other nations. He thought the best thing a young man could learn was that competition would follow him through life. An Englishman ought never to be afraid of competition, and if he did his work faithfully was sure of success in any part of the world. The work of the students was exhibited in the shops and offices, and as usual was very creditable, including some interesting dynamo work in the electrical section.

## NOTES.

**Electric Light in Churches.**—Arrangements for the complete lighting of the Church of St. Jude, South Kensington, by electricity, have just been concluded between the Vicar and Churchwardens, and the House-to-House Electric Light Supply Company, Limited, of Richmond Road, West Brompton. The installation is to consist of 275 incandescent lamps of 8 candle-power, the existing gas fittings being utilised in nearly every instance for the distribution of the light. The nave, for example, will be lighted by 144 lamps; 12 lamps to each of 12 coronas. The chancel will absorb 66 lamps, 30 on two standards in front of the altar, and 36 on four standards for the choir stalls; 18 lamps will be distributed on brackets round the galleries, and 28 for the lighting of the aisles. There will be 5 lamps within and about the organ, one of them being a portable lamp, to facilitate tuning operations, &c., without the danger involved in the use of matches and of exposed gas burners. The remaining lamps go for the lighting of the vestry, gallery stairs, &c., &c. The whole installation will be completed, connections made with the company's mains, and the current supplied within about a month.

**Electric Lighting at Portsmouth.**—The new Portsmouth Town Hall, which was declared open with befitting ceremony by the Prince and Princess of Wales on Saturday, has been temporarily illuminated at night by the electric light. The Admiralty kindly placed the services of Mr. Lane, dockyard electrician, at the disposal of the corporation, and that official and his staff brought to bear on the magnificent building three search lights of 25,000 C.P. each. The general effect was heightened by some interesting experiments in colour.

**Southampton and the Electric Light.**—At a meeting of the Town Council it was resolved to refuse the offer of the local electric light company, which wanted £750 for the licence obtained from the Board of Trade.

**Electric Light at Ilkley.**—It is said that there is a probability of the town authorities adopting the electric light.

**Electric Lighting at Sydney.**—Electric light plant has been erected in the Hotel Metropole for supplying 700 incandescent lamps. The installation was designed throughout by Drake and Gorham, and the work was carried out at Sydney to their instructions and specification by Mr. J. A. Arnot, of the Union Electric Company, of Australia. The plant is considered one of the finest and most successful hitherto erected in the colonies.

**The Tory Island Signal Station.**—The *London-derry Sentinel* of the 7th inst., states that the opening of the signal station on Tory Island has been arranged to take place on the 26th inst., when the opening ceremony will be performed by her Grace the Duchess of Abercorn, who will send the first message to the Queen. The event will be made the occasion of an excursion to the island, and the steamer *Thistle*, of the Laird Line, has been secured for the trip. On arriving off Tory, the *Thistle* will sail round the island, enabling the visitors to obtain a good view of it, and off the Greenport a floating despatch-case, containing the Duchess's telegram, and those of any members of the party who may be desirous of investing a shilling for a telegram from the furthest point in the Atlantic within the area of the United Kingdom, will be dropped overboard, picked up by a boat from the island, and taken to the signal station, whence the messages will be despatched to their destinations in all parts of the kingdom. This will be the first practical experiment of Mr. McNeill's scheme for communication with passing Atlantic liners which Lloyd's Committee have adopted.

**Is it Visual Telegraphy?**—In the *Evening Standard* of the 9th inst. we read the following:—"Telegrams from the Azores state that the continued drought is causing great damage to the crops, and creating financial and commercial difficulties, in consequence of which the inhabitants are protesting against the fresh taxes recently imposed." We fail to see how a telegram can come through a cable which does not yet exist, although so frequently proposed.

**Appointment.**—We are informed that our note last week to the effect that Mr. A. R. Bennett had been appointed engineer-in-chief to the Mutual Telephone Company was, at least, premature. Mr. Bennett has resigned his post of general manager in Scotland to the National Telephone Company, but, so far, has not entered into an engagement elsewhere.

**New Primary Battery.**—A company is in process of formation to manufacture a new primary battery for telephonic purposes.

**The E.P.S. Monopoly.**—It has for some time past been rumoured in electrical circles that the monopoly held for this type of storage battery could be broken down by the expenditure of £10,000 in the law courts, and it is probable that an attempt will, at no distant date, be made to effect this object.

**Electrical Engineering in Melbourne.**—Owing to the repeated request of students, a class has been formed at the Working Men's College, Melbourne, in electrical engineering. Over 90 students have enrolled for the first term, and Mr. A. J. Arnot, M.I.E.E., late engineer in charge of the Grosvenor lighting station, has been appointed instructor.

**Cost of Arc Lamp Trimming.**—The manager of an American firm has introduced the system of paying lamp trimmers on a piece-work basis. Previously they received \$2 a day; now they are able, being paid 2 cents per lamp, to make as much as \$65 a month. Each man, on the new basis, looks after, on an average, 100 lamps a day.

**An Arc Cigar Lighter.**—An interesting novelty has been made by an American firm for cigar lighting. It consists of a small arc lamp, the mechanism of which is hidden. By pressing a button the arc is started, and the mere application of the cigar lights it uniformly. The lamp consumes only half an ampère at an E.M.F. of 50 volts. The cost, it is claimed, does not exceed 8d. a month. It can be readily transformed into a table lamp by the addition of an ornamental shade.

**The Work of Street Cars.**—Recently compiled figures show that there are in America and Canada nearly 9,000 miles of street car track. Out of this number about 6,000 miles are worked by horses, and 2,000 by electricity. This is a wonderful percentage when we consider that electric cars have only been working about five years.

**Gas Engine Wanted.**—The clerk of the Cokermonth Local Board requires an estimate for furnishing and fixing a gas engine for raising water. Particulars on application to Messrs. Pickering and Crompton, civil engineers, Whitehaven.

**Edinburgh Exhibition Awards.**—It has been decided by the Executive Council of the exhibition that no awards will be made in the electrical section.

**City and Guilds Institute.**—On referring to the advertisement, page 12 of supplement, our readers will find the programme for the session 1890-91. The entrance examinations will take place on September 22nd to 24th for the Central Institution, and on September 30th for the day department of the Technical College, Finsbury. Full particulars may be obtained at the office of the Institute.

**Electricity in Fulham.**—The vestry has refused the application of Mr. S. Morse, on behalf of the Chelsea Electricity Supply Company, for permission to run electrical trams through Fulham.

**Correction.**—In the portion of the Institution paper, "The Working Efficiency of Secondary Cells," published last week, the following corrections should be made: Page 167, first col., 5 lines from the bottom, for 0.045 ohm, read 0.0045 ohm; second col., 2nd line, for 0.11, read 0.011 ohm; 3 lines from bottom, 0.038, read 0.0038 ohm; page 168, 2nd line, first column, 0.09, read 0.009 ohm.

**German Telegraph Employés and Uniforms.**—The German Emperor has now, by a recent warrant, given a special uniform to the ladies employed by the Administration of Posts, Telegraphs, and Telephones. Henceforth these ladies will have to wear a knitted blue jersey with orange yellow collar—similar to the officers of German dragoons—with metal buttons and ornaments. The Berlinese who have seen the innovation, find the effect charming; but the unhappy young women, it appears, do not feel any goodwill for Herr von Stephan, the Postal Secretary of State, for the new attractions which he has procured for them. Probably, as everything German is just now so popular in England, from the *Pickelhaube* downwards, we shall soon have our telegraph employés put into "uniform."

**Foreign Trade.**—The exports during July of telegraphic wires and apparatus connected therewith, amounted to £56,575, as compared with £32,909 in July last year, and £21,571 in July, 1888. For the seven months ended 31st July, the figures were £778,287 in 1890, £609,365 in 1889, and £265,784 in 1888. The value of the imports of copper ore for the month was £62,702 this year, £87,530 in 1889, and £135,692 in 1888; regulus and precipitate, £347,775 this year, £312,492 in 1889, and £404,495 in 1888; while unwrought and part wrought copper amounted to £347,775, £312,492, and £404,495 respectively. The imports of caoutchouc were £159,209, £131,883, and £117,363, and of gutta-percha £43,657, £47,531, and £7,623.

**Tramway in Lombardy.**—Some time ago a project for an electric tramway between Lodi and Chignole was brought forward, but owing to the high initial expenditure required, the scheme was left in abeyance. Mr. Pietro Zoncada has revived the project and proposes to reduce the amount of capital necessary so that the tramway may be built. A company is shortly to be formed to construct the line which will be the second in Italy.

**Woodhouse and Rawson United, Limited.**—The contract department of the above firm held its annual excursion on Saturday, August 2nd, when a most enjoyable day was spent, Brighton being the scene of revelry. After dinner, everyone was pleased to hear, from the chairman, of the rapid strides the department had made during the past year and musical honours were accorded to the healths of Messrs. Reginald J. Jones and B. Thomas, their energetic engineers.

**Deeper and Deeper Still.**—A subterranean Eiffel Tower for London is the discovery of a Florentine journal, according to which, a company has been formed in London to construct a huge shaft bored to the depth of 1,500 feet, with lifts, platforms, and restaurants at various depths, and geological collections showing the points of the various strata traversed. It will be lighted by electricity, and will have "a scientific as well as a merely recreative purpose."

**Re The International Cable Company, Limited.**—Mr. Justice Stirling has fixed Thursday, the 21st inst., at 12 o'clock, at his Chambers, Royal Courts, Strand, W.C., as the time and place for the appointment of an official liquidator of the company.

**Dissolution of Partnership.**—The partnership between Messrs. Jno. Shaw, Thomas Connolly and William Speakman (Shaw & Connolly), electrical engineers at the Newton Electrical Engineering Works, Newton Heath, Manchester, has been dissolved by mutual consent from the 5th inst.

**Electric Belts.**—It is almost a hopeless job to try and educate the daily press to such a point that they will decline to insert the advertisements of the purveyors of electric belts and similar appliances, but better things are to be expected of a journal which professes to be of a quasi-scientific nature. Yet, week by week, a contemporary inserts the announcements that Harness's belt is "a safeguard against rheumatic and nervous affections, liver and kidney diseases, and ladies' ailments," and possibly, also, corns, the potato disease, cholera morbus, scarlet fever, housemaid's knee, and all the ills that flesh is heir to. We should be glad if some explanation of the circumstances were given, and to learn whether our contemporary is prepared to assert a belief in the statements put forward.

**The Edison Phonographic Toy and Automaton Company, Limited.**—The following has been issued by the secretary to applicants for shares:—"I am instructed by the Board to inform you that questions having arisen as to the ownership of certain of the patent rights proposed to be acquired by this company, the directors have decided that at present it is undesirable to make any allotment of shares. Kindly, therefore, send in the banker's receipt for the amount paid by you on application, and I will forward you cheque for the amount paid by you per return of post."

**Peculiar Accident in Edinburgh.**—On Monday night a newsboy accidentally fell from the top of an electric lamp-post at the foot of the Waverley Steps, and was picked up insensible. He was taken to the Royal Infirmary, where it was found that his skull was so severely fractured that his recovery is considered rather doubtful. By some of those who witnessed the accident it is supposed that on climbing to the top of the post—a height of about 14 feet—the boy came in contact with the electric current, and was really flung to the ground by the severity of the shock. This, at all events, is clear, that his fall broke the wire or cable, and left the entire Waverley Station in darkness, so far as the electric light was concerned. Men had to be summoned to light the station gas-lamps.

**Electric Traction.**—A minute of the Tramways Committee of the Glasgow Town Council states that a letter had been received from the Electric Tramcar Syndicate, Limited, bringing under the notice of the committee their system of electric traction. Consideration of the matter has been postponed.

**The Gaulard Monument.**—The monument recently erected at Lanzo, Italy, to M. Gaulard, by the Societa Elettricità Italiano, of Milan, was inaugurated on the 3rd of the current month.

**Fareham Electric Lighting Poles.**—The Grand Jury at Winchester Assizes returned a true bill against the Fareham Electric Light Company, the contractors, and three other persons, charging them with committing a nuisance in erecting poles. On behalf of the prosecution, application was made to Mr. Justice Mathew, in accordance with the usual practice in such cases, for an order that the case should stand over to the next Assizes, to give the defendants an opportunity of pleading to the indictment.

**Telegraphy in San Salvador.**—A Consular report states that there is now a total of 89 telegraph offices in San Salvador, with about 1,467 miles of wire. The telegraph service, in general, is satisfactory. The rate for an inland message, or one to any of the four sister republics, consisting of five words, and not including the address and name of sender, costs 1 real 12½ c., or about 4½d.

**Telephones in San Salvador.**—The same authority announces that the telephone service of San Salvador has a wire mileage to the extent of some eighty leagues, and when the lines in construction are completed, it is computed that there will then be wire employed extending to 110 leagues. Private telephones in use number 111, whilst in the Government service 48 are employed.

**Cable Testing.**—There has just come to hand a letter on this subject from Mr. H. Cuthbert Hall, which will receive the attention it deserves in our next issue.

**A Real Electrical Locomotive.**—Says the *Victorian Electrical and Telegraphic Journal*:—"The following graphic description of a locomotive charged to a high tension with electricity has been brought before our notice:—"When the engine commenced to blow off, the engine seemed to be charged with electricity to such an extent that it was as much as I could do to hold the lever, and if ever I put my hand on the iron bucket and touched the lever with the other hand, the sparks seemed to come out of the tips of my fingers. It would even give a shock *through the clothes* when in contact with the lever wheel." This last statement is, we think, slightly overdrawn, and further particulars of the thinness and texture of the interposing garments would be acceptable. The phenomenon is not novel, but any accounts from eye-witnesses would doubtless prove interesting to our readers, who may try and solve its probable cause."

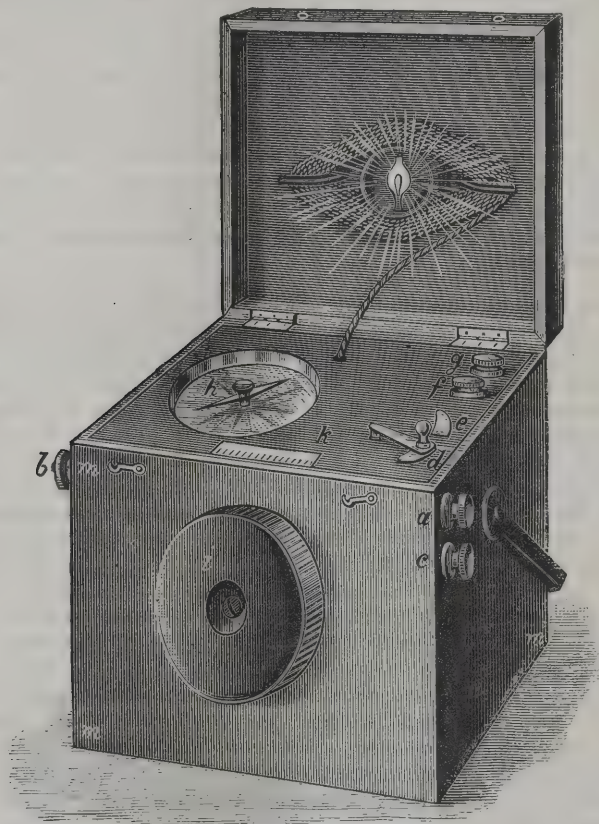
**Increasing Locomotive Traction.**—On June 16th, Mr. C. Selden, telegraph superintendent of the Balt. and Ohio R.R., read a paper before the Railway Telegraph Superintendents' Convention, Niagara Falls, on "Increasing Locomotive Traction by the use of Electricity." In this we read "efforts were made some 15 years ago, by an Englishman named Wederman, to overcome the non-adhesion by winding the spokes of the driving wheels with wire, thus making a magnet of the wheel, with the view of, by magnetism, attracting the wheel to the rail, thus increasing the friction, and thereby the adhesion to the rail of the locomotive. Having but a primary battery, the results were so slight as not to be appreciable." Mr. Selden is grievously in error; the so-called Englishman was a German named Werdermann; the wire was not wound on the spokes of the driving wheel, for the wheel was made hollow and divided into two separate halves, the wire being coiled inside on the axle; and instead of a primary battery, Mr. Werdermann used a very powerful Gramme machine. The result, however, of his experiments showed that a pull of half a ton would detach the rail from the wheel, so the idea of using magnetism to increase adhesion, to any useful extent, was abandoned.

**American Promptness.**—*Apropos* of the great fire, involving a loss of \$125,000, which took place in the Western Union Building, New York, on Friday, July 18th, *Electric Power* remarks:—"The astonishing recuperative power of American business men was never better shown than in this fire. In less than a week from the time of the fire, everything was again in perfect running order, and the immense business of the company was handled with accuracy and promptness."

**China and Japan Telegraphs.**—The Hong-Kong Chamber of Commerce, and other Chambers in China and Japan, have presented a petition to the Queen in opposition to the ratification of the pending Convention between the Chinese Government and the Eastern Telegraph Company and the Eastern Extension, Australasia and China Telegraph Company, Limited. The petition complains that the Convention has for its object the monopoly of telegraph business between China and the outer world, and that the continuance of present extreme rates for the transmission of messages must prove detrimental to commercial and other interests generally.

**The Compound Winding Case.**—The Anglo-American Brush Corporation has intimated that it will appeal to the House of Lords. What good can come out of this is better known to the Corporation than to us.

**The Central Station Companion.**—A combination instrument, called "The Central Station Companion," has just been invented by Mr. H. J. Dowsing and Mr. A. A. Day, the leading features of which are its compact form and simple arrangement, qualities which are greatly to be recommended. The "Central Station Companion," as usually made, is of the following dimensions, viz.: 6 inches by 8 inches by 4 inches, and contains:—1. An ordinary detector or galvanometer. 2. A Wheatstone bridge to measure from .05 to 50 ohms. 3. A standard ohm. 4. A variable resistance or rheostat. 5. A set of four small accumulators for giving a light when testing. 6. Necessary switches, connections, contacts, &c. If required, a 10-ohm standard coil can be inserted to increase the readings tenfold. An essential



feature of "The Central Station Companion" is its simplicity. Any workman can use it, and as there are no loose keys, complicated coils, or calculations to make, mistakes cannot occur. To use as a detector, the ends of the circuit must be connected to the two end terminals, and the key pressed, when the battery and galvanometer are put into circuit. To use the Wheatstone bridge, all that has to be done is to insert the resistance to be measured between two of the terminals and turn the knob in front (which inserts more or less resistance), while pressing keys until there is no deflection in the galvanometer. Then read the actual resistance from the scale. As above stated, there are no calculations required, and the resistance in ohms is read off direct. With a little adaptation the instrument can be used as a potentiometer, or for comparison of potentials, by Poggendorff's method. The incandescent lamp is a useful addition to the testing set, and makes the instrument useful as a portable lamp, and the battery can readily be charged at any of the stations where low tension continuous currents are in use. If, however, it is preferred, a special form of Leclanché can be fitted which will run a small lamp for a few minutes, giving ample time to make intermittent tests. It is an important point in connection with this testing apparatus that it can be made to measure higher or lower resistances as required for special purposes. The scales can be given a large range of reading at any desired point,

so that accuracy may be assured. Perhaps the greatest argument in favour of the "Companion," beyond its compactness and portability, is its low price. One of the ordinary size can be obtained at about half the cost of the cheapest form of a Wheatstone bridge.

#### NEW COMPANY REGISTERED.

**Atlas Engine Company, Limited.**—Capital £12,000, in £1 shares. Objects: To acquire as a going concern the Atlas Engine Company, at Poole, Dorset, and to carry on the business of engineers, electricians, electric light contractors, dynamo manufacturers, &c. Signatories (with 1 share each): E. Sparshott West Field, Peter Gotto, both of Poole; C. Lamb Gotto, 54, Oxford Street; J. Foster Penny, 8, Trafalgar Square, Brompton; A. Brunel Armitage, 5, New Broad Street; H. G. Gotto, 54, Oxford Street; J. Haynes, 92, Tufnell Park Road. In lieu of a board of directors, the management is vested in the two first subscribers, who are appointed managing directors, and will each be entitled to a monthly salary of £12 for the first three years, subsequently to be increased as the company in general meeting may determine. Qualification, 500 shares. Registered 9th inst. by Walter Deverell and Co., 5, New Square, Lincoln's Inn.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Electric Traction Company, Limited.**—At an extraordinary general meeting of this company, held at 35, New Broad Street, on the 1st ult., it was resolved to wind up voluntarily, Mr. G. A. Redford being appointed liquidator, with authority to dispose of the company's property to the General Electric Power and Traction Company, Limited, as agreed to by a contract of 23rd May, 1890, between this company of the first part, Moritz Immisch & Co. of the second part, and the General Electric Power and Traction Company, Limited, of the third part. The resolutions were confirmed on the 23rd ult., and were duly filed on the 6th inst.

**Mutual Telephone Company, Limited.**—The nominal capital of this company has been increased to £250,000 in £10 shares, beyond the registered capital of £100,000, in accordance with the resolution passed in general meeting on the 21st ult. The notification to the Registrar of Joint Stock Companies of such increase was filed on the 7th inst.

**Byng Telephone Company, Limited.**—At an extraordinary general meeting of this company, held at St. Nicholas Chambers, Newcastle-on-Tyne, on the 2nd ult., it was resolved to wind up voluntarily, and that Mr. John Philip Spencer, of 48, Collingwood Street, Newcastle-on-Tyne, be appointed liquidator. The resolution was confirmed on the 18th ult., and was duly filed on the 5th inst.

The annual return of the company, made up to the 30th April, was filed on the 5th May. The nominal capital is £5,000 in £10 shares; 207 shares have been taken up, and £8 per share has been called and paid thereon, the paid-up capital thus being £1,656.

**Electric Meter Company, Limited.**—The statutory return of this company, made up to the 1st inst., was filed on the 2nd inst. The nominal capital is £50,000 in £10 shares; 2,007 shares are taken up, 2,000 of which are considered as fully paid. Upon the remaining 7 shares the full amount has been called, but remains unpaid. Registered office, 25, College Hill.

**Durand Electric Petroleum Gas Engine Manufacturing Company, Limited.**—The statutory return of this company, made up to the 29th ult., was filed on the 2nd inst. The nominal capital is £100,000, in £5 shares. 1,907 shares are taken up, and of these, 1,900 are considered as fully paid. Upon seven shares the

full amount has been called, but remains unpaid. Registered office, 175, Strand.

**Crompton and Company, Limited.**—The annual return of this company, made up to the 4th inst., was filed on the 8th inst. The nominal capital is £140,000, divided into 20,000 preference, and 8,000 ordinary shares of £5 each, the whole of which are taken up. Upon 20,000 shares the full amount has been called, the calls paid amounting to £99,980, and unpaid to £20. The remaining 8,000 are considered to be fully paid.

**Elmore's Wire Manufacturing Company, Limited.**—The statutory return of this company, made up to the 28th ult., was filed on the 7th inst. The nominal capital is £300,020, divided into 150,000 ordinary and 10 founders' shares of £2 each. The shares are 64,333 ordinary and 10 founders'. Upon the former £1 per share has been called, and upon the latter the full amount. The calls paid amount to £55,641 5s., and unpaid to £8,671 15s. Registered office, 20, Bucklersbury, E.C.

## CITY NOTES, REPORTS, MEETINGS, &c.

### Maxim-Weston Electric Company, Limited.

AN extraordinary general meeting of shareholders, of whom some fifty were present, was held at Winchester House on Thursday last, when the following resolution was moved by the Chairman, Mr. J. B. Gooding, seconded by Mr. Couchman:—That it has been proved to the satisfaction of the meeting that the company cannot by reason of its liabilities continue its business, and that it is advisable to wind up the same; and, accordingly, that the company be wound up voluntarily.

The Chairman said, in his opinion, the present board of directors was not in any way responsible for the disastrous state of the company's affairs. The company had been started under very unfavourable conditions. It started with a nominal capital of some forty or fifty thousand pounds, of which only fourteen thousand was subscribed. They were acquainted with the manner in which it had been spent; the company was now practically without resources and the directors felt compelled to ask them to pass the resolution before them. A meeting had been held to ascertain the feeling of the shareholders with regard to subscribing any more money to keep the company going. Although some £1,500 pounds had been promised by way of debentures, that was not nearly sufficient to admit of the concern being carried on. Before submitting the resolution he read a few figures connected with the working of the business during the past six months. The company had on January 1st, roughly, £5,000 in hand; it had since received on account of shares £30; for transfer fees £5; bank interest on deposit £13 10s.; a loan of £50; on accounts collected and for work done £1,200, making a total of £1,303 4s. 5d., or a gross amount of £5,700. The company had paid for directors' fees £148; salaries £467; wages £336; rates and taxes and rent £220; gas account £106; travelling expenses £28 4s. 4d.; petty cash £125; trade accounts £2,255; liquidation costs and other expenses incidental to legal proceedings £970; making a total of £4,658. That left a balance of £1,031, of which £1,000 lay in the bank to the credit of the liquidators of the old company. The company's present liabilities amounted to £256; cash in hand and accounts to be collected to £74, and as assets to be received from St. Margaret's Mansions—but whether recoverable remained to be seen—£300. So that although the company's affairs were in a very bad state it would go to the wall without taking anybody there, i.e., it would discharge its liabilities. The directors had received one or two very encouraging letters from shareholders, but the result of the last meeting had been so unsatisfactory that they had thought fit to draw up the resolution which was now before the meeting. In reply to a shareholder, he further stated that the action against Mr. Watt was still pending; the solicitor thought it more than likely to be completed within the present year, after the vacations. With regard to the position of the company with reference to the liquidators of the old company, the property of the present company had not yet been assigned to it by the old liquidators. The present position was this: any assets realised by the sale of the company's property, would, the directors had been informed by the solicitor, be required by the liquidators of the old company to be deposited at the bank pending Mr. Watt's action. He, the chairman, could not altogether reconcile that with the statements and actions of the old liquidators in the past. The directors were told in the first instance that £1,000 would cover everything, next that £2,000 was required, and now they were told that a liquidator of the new company selling any of the company's effects would be unable to touch one farthing of the proceeds. So the company was practically at the mercy of the liquidators of the old company, and he, the speaker, could not congratulate the shareholders on occupying that position. He for one did not feel at all comfortable.

A Shareholder: Who is responsible for that state of affairs.

The Chairman: I should say the solicitors of the present company, because they did not require the old liquidators to assign.

The Solicitor: That is not the fact. This company has everything it is entitled to. What is there that it has not had beyond some four or five thousand pounds that can be realised by selling the company's effects? The chairman altogether fails to recognise that the interests of the old liquidators and of the present company are identical. Anything they may recover will be for this company's benefit; but very naturally they say "We are making ourselves personally responsible for costs and liabilities, and therefore the new company must indemnify us in case we lose." Is not that right and proper?

Several Shareholders: Yes.

The Chairman: I certainly think the solicitors should, in the interest of the present shareholders, have seen that the property was legally assigned.

A Shareholder: Surely when the new company was formed, its relation to the liquidators of the old company was defined by some contract or agreement, and surely the directors of the new company would have seen that that contract was so framed as not to place them entirely at the mercy of the old liquidators.

The Chairman: Some months ago I called attention to the fact that the liquidators declined to convey the property of the company. I now believe that this was through an oversight on their part. But I say in the interests of this company the solicitors should have seen that the property was actually assigned. Your liquidators cannot touch one farthing of the assets as matters stand. The identity of interest spoken of by the solicitor is only apparent. We have ceased to require the services of the old liquidators, and, speaking as a shareholder, I am not satisfied to let them have their own way. With one exception, I have no confidence in them at all.

The same Shareholder: When the new company was formed there must have been as part of the reconstruction scheme, a contract that the liquidators should on some terms or other convey the property to the new company.

The Solicitor: There was a contract to convey subject to the liquidators' claim to be indemnified for any responsibility incurred by them. Why should they have taken upon themselves these liabilities for the benefit of the new company without an indemnity. I repeat their interests and yours are identical, and I am astonished at what has fallen from the chairman. It is not true that I have not called the attention of this company to the fact that, as yet, there has been no assignment.

The same Shareholder: If there was no proper contract of a kind to prevent the new company from being placed entirely at the mercy of the old liquidators, some one ought to be held responsible. If you pass this resolution you should be careful whom you appoint as liquidator.

The Chairman: the solicitor says this contract to assign exists under certain conditions. We say we have fulfilled those conditions. Now the solicitor tells us that, no matter what may be sold, the liquidators will not allow one penny to go out until Watt's action is decided. Therefore, pending that decision, we have nothing. The solicitor of the company should have insisted on the property of the old company being conveyed to us. In reply to a shareholder, the chairman said that they would have a larger sum to pay for legal expenses than the sum mentioned above, before the affair was concluded. He also said the company had had to abandon its contracts owing to want of ready money. The directors might have obtained credit, but had not seen their way to incur fresh liabilities. The company had just sufficient to pay its present debts.

Mr. Marks: I am surprised to hear the chairman say that the old liquidators will not consent to see a sixpence worth of the company's property parted with unless the funds pass through their hands. The liquidators were called upon by the shareholders to prosecute the action against Mr. Watt. It makes no difference to the company whether the property has or has not been assigned. The liquidators of the old company made an agreement with the new company, by which the new company undertook to indemnify the liquidators for any costs incurred in the action against Watt, and the assets of the old company, and also of the new company, were made liable for any sums paid by the liquidators in the action. The property has not been assigned simply because there was no need; but had they done so, the liquidators would have taken care that the new company deposited such a sum as would cover any costs incurred in the action. As one of them, I have no objection to the assignment. (To the solicitor): You would be satisfied to advise the liquidators that they would be perfectly secure if £1,000 were placed to their credit?

The solicitor assented.

The Chairman: At the last meeting of the board, the solicitor said that no matter what the present company or its liquidators might sell, the old liquidators would not allow any of the money to be spent.

The Solicitor: What I said was, that the liquidators would naturally require the liquidators of this company to indemnify them in the action against Watt.

Mr. Marks: We are prepared at this moment to execute the assignment subject to something further being placed to our credit.

Mr. Hodgson, a director: The dynamos we possess are very good of their kind, but an electrical company to succeed must progress, instead of like their late managers being content to consider themselves the best electrical company in the world and allowing some of the patents to lapse. The company has still a

very fine plant, and with proper prudence we might yet undertake small installations, only the money we have obtained has been so insufficient as to oblige us to go into liquidation. The dynamos are worth a thousand or two.

The Chairman: You will receive not one farthing if this company goes into liquidation. To carry on the works you require a capital of £100,000 at least. By confining your operations to lighting and private installations there is, I think, still a legitimate business to be done with a small capital.

A Shareholder: Whatever liabilities this company may incur we have sufficient assets to liquidate them?

The Chairman: Most certainly.

Mr. Marks: Your liabilities amount to about £300.

The Chairman: Yes.

Mr. Marks: And you estimate the value of the plant at your works at about £7,000 as a going concern?

The Chairman: Yes.

Mr. Marks: Don't you think the sense of the meeting ought to be taken as to reconstruction? No doubt there is a gigantic field of work open to competition for a considerable time.

A Shareholder: We have let everything go to the wall.

The Chairman: I am willing to admit that as much has not been done as ought to have been. But we have been employing travellers; and we have erected a private installation in Ireland which is giving satisfaction and is a splendid advertisement. But we have no capital to go on with.

A Shareholder: I do not see that it has been satisfactorily proved that we cannot continue our business. You say you have no liabilities beyond £300 except Watt's action, and you say you have £7,000 worth of plant.

The Chairman: I cannot conceal the fact that each one of the directors has already lent money to enable the company to pay its weekly wages. It is true we have been repaid but in a very haphazard manner. No doubt in the coming winter an enormous amount of lighting will be done.

A Shareholder: Is it not true that some important contracts have been lost by us simply because it was expected the company would come to grief? The Aquarium for instance?

The Chairman: The Aquarium is still open. The step which is embodied in the resolution now before you has not been taken hurriedly or rashly. We called a private meeting of shareholders but they never came.

A Shareholder: I have heard a rumour that if the meeting does not come to any resolution to-day, a petition for winding up the company will be presented to the Court to-morrow.

Mr. Hodgson: If we had £3,000 we could do a lot of work and I would personally see that the money was not wasted.

The Chairman: I have always said that the works were a clog upon our action, having no capital.

Mr. Marks: I beg to move an amendment that this meeting adjourn for a fortnight, and that in the meantime the board invite a certain number of the largest shareholders to confer as to a basis for a reconstruction scheme. I know as a fact the company has lost a good many lighting contracts owing to its not being in a position to take them in hand, the Royal Military Exhibition at Chelsea, the Waterloo Panorama, for instance. But you have laid foundations for securing many such contracts in the future, and I cannot help thinking that if the shareholders are invited to find funds for a solid reconstruction scheme, you would yet have a future before you.

The Chairman: Gentlemen who support the amendment should hand over their cheques for a sufficient sum to meet our present liabilities, viz., £300, or we shall be served with writs, and petitions will be filed.

A Shareholder: I cannot see how you are going to induce shareholders to find fresh money. £14,000 has already been frittered away at the rate of £1,000 a month and no trading has been done for it. I am prepared to support a scheme for reconstruction if Mr. Marks will consent to become liquidator, associating himself with Messrs. Hodgson and Couchman.

The resolution to voluntarily wind up the company was then put and carried.

An attempt was made, and failed, to bring in an outsider, Mr. Newson Smith, as liquidator, and Messrs. Marks and Hodgson were ultimately appointed. The proceedings then terminated.

### The City and South London Railway Company.

THE directors' report was laid before the shareholders in meeting at Winchester House, on the 12th inst. at noon, Mr. J. Grey-Mott presiding.

The Chairman said they would recollect that at the time of their last meeting the Stockwell Tunnel was incomplete, but was being steadily driven through a strata of wet gravel. That had now been completed without any mishap, and since the whole of the tunnels were now finished, the shareholders might accord their best thanks to the engineers and contractors for the exceptionally successful way in which they had carried out a work of exceptional difficulty. He believed there was hardly a record anywhere of so long a tunnel being driven with so little loss of life or accident. The completion of the tunnel had been followed by the completion of the permanent way through it; the electrical main cable had also been completed in both tunnels, as also the service of the conductor, by which electricity was conveyed to the locomotives. The lifts had taken a much longer time to construct than had been anticipated, by Sir William Armstrong's firm, and this had

necessarily caused some delay in the final completion of many of the works connected with the stations and approaches. They were now, however, making very satisfactory progress. The underground stations were practically all completed, and those above ground were very nearly so. Arrangements for lighting them electrically with light taken from the ordinary conductors used for lighting the town had been temporarily abandoned, it having been found that taking the light in that way would involve certain fluctuations, and also it would consume a considerable amount of power which the directors were unwilling for the moment to take from the general propelling power. They had, therefore, thought best to make provisional arrangements for lighting the stations with gas. These and also the signalling arrangements were nearly complete. At the depot there were three hydraulic engines for compressing the water by which the lifts would be worked; they had been tested, as also had been the pipes and accumulators, and were in good working order. There were three very powerful vertical engines for driving the electrical current dynamos; one of them had already been worked with one dynamo with very satisfactory results, and the second vertical engine and dynamo would, he believed, be worked for the first time that day. The third, which was held in reserve, was also completed, or nearly so, and he believed that in the course of the next two or three weeks the whole of the electrical plant would be in working order. The engine and carriage sheds had been roofed in, and were in other respects ready for use. So that the shareholders would see that the great bulk of the work had been completed. A great deal of the rolling stock was ready; some engines were on the spot, and, he was happy to say, the engines and carriages had been run the whole length of the line with electrical power at a greater speed than was actually required for the service of the line. They had therefore no cause to doubt that in a very short time the railway would be open, and, as regards the working, they had every reason, judging by the experimental trials which had taken place, to anticipate that there would be no difficulty on that score. The directors were now making arrangements for a working staff, and, of course, being perfectly new, it would be necessary that the staff should be given an opportunity to become acquainted with their duties, and therefore the line would be worked for a short time before being thrown open to the public, and, in fact, the engine-drivers were already practising their duties. Thus the risk of failure afterwards would be avoided. He would be very sorry to commit himself to a date after the delay which had already taken place, and he would therefore only express the hope that by the end of next month the line would be in a condition to be opened. The Bill for extending it to Clapham had received the royal assent and the name of the company had been changed to that of the City and South London Railway Company. The directors proposed at a special meeting, following the practice of all railway companies, to create the capital authorised by the Act, but they had no intention to make the extension until the line should be in proper working order. Referring to the Central London Railway Bill, he said that it had somewhat departed from the principles upon which they of the City and South of London had been working. Its proposal for a junction between the two lines would have been practically unworkable, and had been ultimately withdrawn. The Bill had now, after long enquiry, been thrown out, and he, the Chairman, was inclined to think the decision of the Lords a wise one, because the Bill had not been conceived upon the lines of the City and South London Company, nor, in his opinion, upon lines which would have made it a profitable undertaking. Possibly it would be reintroduced in an improved form, and, in that case the City and South London Company would be happy to co-operate in any workable scheme. In the meantime, many points would have to be considered in regard to any proposed extension by which the company might obtain a more complete control of the city traffic than it already possessed. That might be done at comparatively small cost. Up to the present the company had only spent some £860,000, which was very close to the original estimate. Upon that policy the future earnings and dividends of their company, and of other city underground railways, must depend, because when they exceeded beyond a certain sum, it became practically impossible for a line of railway to earn a really good dividend whatever might be the traffic; it being all essential that the capital cost should be kept within a defined and known limit. They saw what a very poor return the Metropolitan and Metropolitan District Railways gave for their enormous traffic. It was a warning which ought never to be forgotten in any extensions they might make. He begged to move the adoption of the report.

Mr. Hanbury seconded, and the resolution was agreed to unanimously.

At an extraordinary meeting held immediately afterwards, the Chairman moved to convert the share capital into stock to facilitate its transfer. He added that it was not proposed to carry it into effect immediately, or before the share capital had been more completely issued. As a rule all railway companies found it more convenient to have the capital in the form of consolidated stock. The resolution was seconded by Mr. Hanbury and agreed to, and the proceedings terminated with a vote of thanks to the chair.

### The Chili Telephone Company, Limited.

THE directors' report (printed in our issue of August 1st), and the accounts for the half-year ended March 31st, were presented at the annual general meeting of the shareholders at Winchester House, noon, August 8th, Colonel Raynsford Jackson presiding.

The Chairman said the shareholders, who had doubtless read in the prospectus that the directors anticipated a dividend from the very commencement of 6 per cent., would be inclined to ask how it happened that the report only mentioned one of 5 per cent. In the first place, when the prospectus was issued, the rate of exchange was 26d. per dollar, whereas it was now fallen to 24d., and the average rate of exchange during the eleven months over which the accounts extended had been 25½d. Had it continued all through at 26d., the company's earnings would have been between £900 and £1,000 more, and the dividend anticipated would have been realised. The directors had had still another difficulty to contend with, one which had deprived the company's general manager in Chili of the control of the company's affairs up to the middle of the last month of its financial year. It happened in this way: There was an unregistered body of shareholders in the West Coast Telephone Company residing in Chili, who, through not having had their shares registered, had been left in ignorance of the affairs of the West Coast Company until they suddenly learned that their property had been sold. They imagined that the sale price was over and above the amount of the West Coast Company's liabilities, and, therefore, that they were entitled to be paid a very large sum of money. They were entirely mistaken, because the West Coast Company's system had been purchased on the understanding that that company met its liabilities, and therefore all that these shareholders were interested in was the surplus left to the company after meeting its liabilities, which proved to be a very small sum indeed as compared to their anticipations. They thought to protect their interests by preventing, pending satisfaction of their claims, the legal registration of the transfer of the West Coast Company's system to the Chili Company, by means of an injunction obtained in the local court. The consequence was that the management of the Chili Telephone Company remained in the hands of the vending company until the middle of April, when arrangements were made for the appointment by the West Coast Company of the Chili Company's manager as their manager also. Thus the company's manager had now a recognised position which enabled him to look after the company's affairs, introduce economy, improve the service, and otherwise develop and promote the company's interests. In spite of these difficulties the company's progress had been satisfactory. An increase had taken place during the year of 33 per cent. in the number of subscribers, and in the gross revenue of the company; and he thought a still larger increase might be anticipated for the present year, not merely because the difficulties above-mentioned no longer existed, but also because the company had purchased for £36,000 the National Telephone Company of Chili, the only rival it had in the country. That company had possessed important local influence. It was formerly controlled by natives who enjoyed considerable power and influence in Santiago and Valparaiso, and who had shown themselves very hostile to the Chili Telephone Company, and had co-operated with the dissident shareholders of the West Coast Company in doing the company considerable damage. Having bought off the opposition of the National Telephone Company of Chili, the company had also weakened the position of the dissident shareholders; and he thought he might now hold out an assured prospect of its anticipations being realised, and of the shareholders possessing a property of real intrinsic and sound value. He moved the adoption of the report and accounts.

Mr. T. Greenwood seconded, and the motion was carried unanimously.

The Chairman also moved to declare a dividend of 2s. 6d. per share, as recommended, payable at the company's bankers on and after the 9th inst., free of income tax.

The Hon. F. E. Allsopp seconded, and the motion was carried unanimously.

The Chairman, in moving the re-election of Mr. T. Greenwood as director, spoke in warm terms of the services of that gentleman in connection with the negotiations referred to above. The motion was seconded by Mr. Venables, and agreed to.

The Hon. F. E. Allsopp was also re-elected a director, Mr. T. A. Welton was re-appointed auditor, and with a vote of thanks to the chair the proceedings terminated.

### Liverpool Overhead Railway Company.

THE fourth half-yearly meeting of the shareholders of this company was held recently in Liverpool. Sir Wm. B. Forwood, the chairman, presided. The report of the directors stated that the progress in the construction of the railway during the past half-year had not been as great as they had looked for. Difficulties of a technical character had arisen, but these had been surmounted, and already several complete spans were in position, and the directors had every reason to believe that henceforward the erection will proceed with rapidity. The expenses of administration had been defrayed out of interest on capital paid up, and the balance of revenue account had increased to £1,129 0s. 5d. The general balance-sheet, made up to June 30th last, showed on the debit side the following items:—Balance at credit of capital account, £105,223 1s. 7d.; balance at credit of revenue account, £1,129 0s. 5d.; amount retained as security for completion of contract No. 1, £1,295 7s. 9d.; owing to sundry creditors, £547 19s. 1d.; total, £108,195 8s. 10d. The amounts on the credit side were £5,427 17s. 5d., deposit £102,767 11s. 5d.; total, £108,195 8s. 10d.

The Chairman explained the position of the undertaking. The works were not actually commenced till October last, and the progress made had not been so rapid as the contractors had led them

to expect. This did not arise out of any difficulty in the construction of the overhead railway itself, that being a very simple matter indeed; but it arose from the automatic machinery which the contractors employed with the view to economy not being in the perfect working order which he had believed. He was glad to say, however, that all the difficulties connected therewith had since been overcome, and the machinery for turning out and drilling the plates was now working perfectly, and the work was being proceeded with as quickly as might be expected. They were now turning out nearly two spans per day, and, if they continued at this rate, the line would be completed in 12 or 13 months. Difficulties were, however, always incidental to works where machinery was employed, and therefore they must not be too sanguine that the work would be finished in the time named. It would be seen from the photographs exhibited in the meeting room that the railway, when completed, would not be an unsightly object. Indeed, comparing it with what he had seen of American overhead railways, this would be the best looking overhead railway he had seen. As to the equipment of the line, they had not yet taken any steps, but, as previously indicated to the shareholders, electricity had been adopted as the propelling power. The progress in this as a motor was such that they had been advised by their engineer to postpone deciding upon the precise system until the last moment. Referring to the £108,195 to their credit in the general balance-sheet, he was glad to say that it was gaining interest, and they would also be glad to see that after paying the expenses of administration for the past half-year, the balance to their credit on revenue account had increased to £1,129 0s. 5d. The Mersey Docks and Harbour Board had agreed to spend a further large sum at the north end in addition to what they had expended at the south. This would considerably increase the amount of traffic upon the railway. From everything he could see they would have a large traffic, and he looked forward to the future with very great expectation. He moved the adoption of the report and balance-sheet.

Mr. Richard Hobson seconded the motion, which was carried unanimously.

A vote of thanks to the chairman terminated the proceedings.

**Birmingham Tramway Company.**—At the annual meeting of the Birmingham Tramway Company, on Wednesday, the chairman (Mr. Smith) expressed the hope that they had seen an end of the fuel boom. They were paying 17s. per ton this year for what they paid 10s. 5d. for in 1887. Nevertheless, the year's operations had been very prosperous. The opening of the electric line in the Bristol Road had been demonstrated to be a scientific and mechanical success. What now remained was to see whether it could be worked with economy. Steam traction cost 3d. per mile; he believed the cost of electric traction would not be far from that sum.

**Sheffield Telephone Exchange and Electric Light Company, Limited.**—It has been resolved to wind up the company voluntarily in view of a reconstruction. Messrs. T. G. Shuttleworth, accountant, and W. Johnson, the secretary of the company, both of Sheffield, are the liquidators, with power to consent to the registration of a new company, to be named "The Sheffield Telephone Exchange and Electric Light Company, Limited," and to make an agreement with such new company.

**The European Electric Welding Company.**—A further payment of £20,000 has been made in Boston by the English purchasers of the company, making £70,000 paid in cash. Payment of the balance, £40,000 and 33½ per cent. of the stock to be issued by the London company, is guaranteed by the City of London Contract Company, the cash to be paid about November 1st.

**The Schanschieff Electric Battery Syndicate, Limited.**—Creditors are further notified to send names and addresses and particulars of debts and claims to Richard Rabbidge, the liquidator, 32, Poultry, London, E.C., on or before the 19th instant, or to be excluded from any distribution prior to such claims.

**Elmore's Wire Manufacturing Company, Limited.**—Application has been made to the Stock Exchange Committee to appoint a settling day, and grant a quotation in respect of ordinary shares.

**The Electric Construction Corporation, Limited.**—Application has been made to the Stock Exchange Committee to allow the company's shares to be quoted on the official list.

### TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending August 8th, were £4,863.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 8th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,761.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 7.)	Closing Quotation. (August 15.)	Business done during week ending August 15, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	97 — 100		
1,549,160	Anglo-American Telegraph, Limited	Stock	49½ — 50½ xd	49½ — 50½	49½	49½
2,725,420	Do. do. 6 p. c. Preferred	Stock	85 — 86 xd	85 — 86	86	85
2,725,420	Do. do. Deferred	Stock	13½ — 14	13½ — 14½	14	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12	11½ — 12½	12½	11½
99,000	Do. do. 5 p. c. Bonds	100	100 — 102 xd	100 — 102	101½	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 2	1½ — 2	1½	...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2	1½	...
\$7,216,000	Commercial Cable, Capital Stock	\$100	103 — 105	103 — 105	103½	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	5½ — 5½ xd	5½ — 5½	...	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	12½ — 13½	12½ — 13½ xd	17½	17½
16,000	Cuba Telegraph, Limited	10	17 — 18	16½ — 17½ xd	3½	3½
6,000	Do. do. 10 p. c. Preference	10	9 — 10	9 — 10	10½	10½
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4	3½ — 4	14½	13½
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½ xd	10½ — 10½	...	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½ xd	13½ — 14½	...	...
70,000	Do. do. 6 p. c. Preference	10	15 — 15½ xd	15 — 15½	...	...
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109 xd	106 — 109	108½	...
1,290,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½	14 — 14½	14½	14½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102 xd	100 — 102	100½	...
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106	103 — 106	103	...
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	103 — 106	...	...
367,900	Eastern and South Africa Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	100 — 103	100 — 103	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½	5½	4½
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	4½ — 4½ xd	5½ — 5½	...	...
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	5	2 — 2½	2 — 2½	...	...
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	8½ — 9½	9½	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15½	14½ — 15½	15½	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16	15½	15½
40,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103	100 — 103	...	...
250,000	Do. do. do. (issue of 1883)	100	106 — 109	106 — 109	...	...
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	12 — 13	12 — 13	...	...
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½	...	...
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18½ — 19½	...	...
200,000	Do. do. 4½ p. c. Deb., 1896	100	102 — 104	102 — 104	...	...
17,000	Indo-European Telegraph, Limited	25	37 — 39	37 — 39	38½	38½
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000	Do. do. do. 6 p. c. Debentures	100	107 — 110	107 — 110	...	...
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4 — 4½	4 — 4½	4½	4½
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4½ — 5	4½ — 5½	5½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 12½	12½ — 12½	...	...
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	10½	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	7½ — 8½	7½ — 8½	...	...
9,000	Reuter's, Limited	8	7½ — 8½	7½ — 8½	...	...
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	4 — ½ xd	4 — ½	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£2½ only paid)	5	2½ — 3 xd	2½ — 3	...	...
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117	...	...
78,949	Swan United Electric Light, Limited	5	5 — 5½	5 — 5½	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	...
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	...	...
55,000	United River Plate Telephone, Limited	5	4 — 4½ xd	3½ — 4½	4½	3½
116,000	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94	...	...
100,000	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10	...	...
300,000	Do. do. do. 5 p. c. Debentures	100	100 — 103	100 — 103	101½	...
30,000	West Coast of America Telegraph, Limited	10	5 — 6 xd	4 — 5	...	...
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	106 — 110	106 — 110	...	...
61,572	Western and Brazilian Telegraph, Limited	15	10 — 10½	10½ — 11½	11	10½
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 7	6½	6½
26,986	Do. do. do. 5 p. c. Deferred	7½	3½ — 4½	4 — 4½	4½	4½
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106 xd	103 — 106	...	...
250,000	Do. do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 — 104 xd	101 — 104	...	...
88,321	West India and Panama Telegraph, Limited	10	2½ — 3	2½ — 3	2½	...
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 11½	11½ — 11½	...	...
4,669	Do. do. do. 6 p. c. 2nd Preference	10	12½ — 13½	13 — 14	...	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125	...	...
179,300	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 101	99 — 101	...	...
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	14 — 14½	14 — 14½	...	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Electric Construction Corporation (£10 paid), 7½—8½  
 Elmore Copper Depositing Priorities, 5½—6½.—Elmore Wire, ¼ dis—par.—House-to-House Company (£5 paid), 5 — 5½.—Inter-  
 national Okonite, Ordinary of £10 (£4 paid), 3½—4½.—London Electric Supply Corporation, Ordinary (£5 paid), 1½—2.—  
 Manchester Edison and Swan Company, £9 (£1 paid), 11/- — 13/-.

BANK RATE OF DISCOUNT.—5 per cent. (31st July, 1890).

## THE RIES ELECTRIC TRACTION-INCREASING SYSTEM.

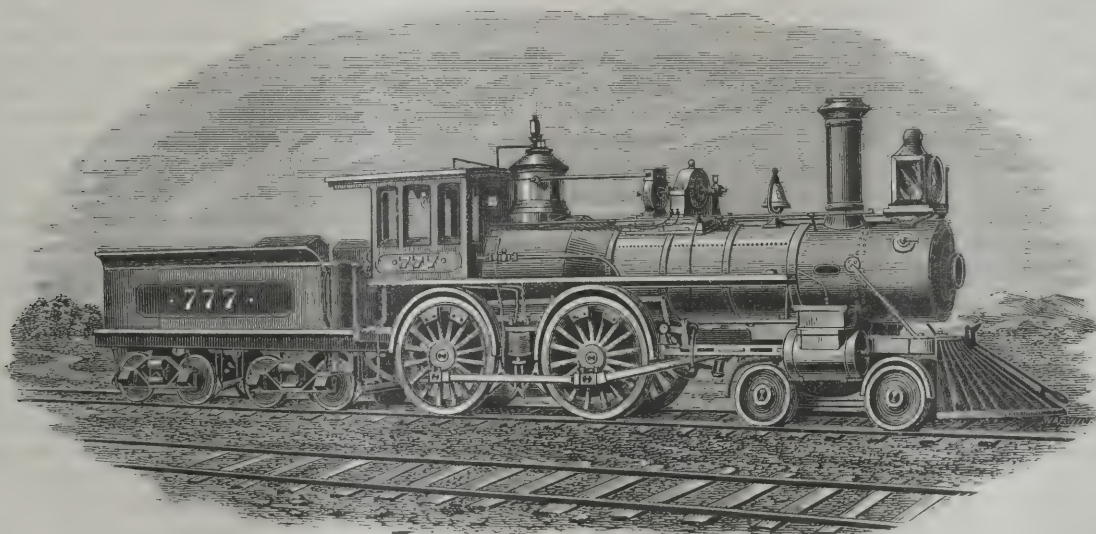
WE have recently devoted considerable space to the discussion of the increased adhesive effect produced between driving wheels and rails and other metallic surfaces when traversed by an electric current under given conditions. Among the contributions upon this interesting subject, we (*New York Electrical Engineer*) have had the pleasure of describing in detail the important results obtained by Mr. Elias E. Ries, during a series of original investigations and experiments extending over a considerable period, in the direction of applying this method of increasing tractive adhesion to steam and electric railway locomotives.

It will be remembered that in this system of electrically increasing traction as developed and practiced by Mr. Ries, a low tension quantity current is made to flow through a local circuit of almost negligible resistance, of which circuit the driving wheels and that portion of the track rails immediately below and between them form the principal part. This current produces a slight local heating or incipient welding

we understand are now in progress on the Baltimore and Ohio Railroad.

Referring to our illustration, it will be seen that the traction-increasing current is generated by a small alternating current dynamo driven by a rotary engine supplied with steam from the locomotive boiler. The engine and dynamo are mounted upon a common base secured to the boiler in the position formerly occupied by the sand box. One or both pairs of driving wheels are electrically insulated from the body of the locomotive and from each other by the use of special insulation surrounding the driving box and side rod brasses. The insulation so far employed has proven itself fully capable of withstanding the exceptionally severe strain to which it is subjected, and tests made after several months of continuous service have led to its permanent adoption for this class of work.

Electrical connection with the two pairs of drivers is maintained by means of peculiarly constructed brushes bearing upon brass sleeves secured to the central portion of each driving axle. These brushes are connected, by means of heavy stranded copper conductors, with the source of low tension current, which in the case illustrated is a transformer (not shown) placed in proximity to the main driving axle. A type of machine is now about to be used, however, which generates



effect at the points of contact between the wheels and rails, which is practically instantaneous in its action, and brings about a decided increase in the coefficient of friction between the opposing metallic surfaces.

Practical interest in the subject has recently been awakened among railway men by the exhibition of working models of this invention at the annual meetings of the Association of Railway Telegraph Superintendents, and of the American Railway Master Mechanics Association, held at Niagara Falls, N.Y., and at Old Point Comfort, Va., respectively, on June 18th and 19th, 1890, at which the new method of increasing tractive adhesion met with considerable favour, the models exhibited showing an increase in traction due to the current of over 200 per cent. Preliminary tests of the invention, as applied to steam locomotives in regular service, have been very successful, and this, together with the favourable reports of experienced railroad officials who have investigated the system, has recently led to the organisation, in Baltimore, Md., of the Ries Electric Traction and Brake Company, with a capital stock of \$2,000,000, for the purpose of further developing and introducing the same.

We are enabled this week to present to our readers, through the kindness of this company, a perspective view showing the general appearance of a steam passenger locomotive equipped with their electric traction-increasing apparatus, and we hope soon to be able to make public the results of the new series of test that

directly the low tension quantity currents required. As the resistance of the traction-increasing circuit is practically constant under given track conditions, the flow of current is usually regulated by varying the electromotive force, which, on account of the low resistance of the circuit and multiple connection of the driving wheels, can be kept very low. The current density at the points of contact between the driving wheels and rails can be varied at will, according to the percentage of increased adhesion desired, the usual range being from 500 to 2,500 amperes.

It is proposed to use part of the current generated by the dynamo, either directly or indirectly, according to the type of machine employed, for the operation of electric locomotive and train brakes, electric headlight and train lighting, &c., in addition to its use for increasing traction. The dynamo is generally kept running at a slow rate of speed when not otherwise employed, and is so constructed as to respond promptly and automatically to any demand that may be made upon it within the limits of its capacity.

Experiments already made upon a large scale have shown that by this method it is possible to increase the tractive adhesion of locomotives fully 25 per cent., thus enabling them, with a saving of fuel, to haul a largely increased load, to mount heavier grades, and to descend the same under perfect control and without the skidding of wheels. Besides this, it will enable railroads to haul, with their present engines, much longer trains

than they can now do, thus not only increasing the carrying capacity of the road, but saving largely the wear and tear upon tracks and bridges that the use of heavier engines for this purpose would entail. It will likewise enable both passenger and freight locomotives to make better speed and to maintain schedule time notwithstanding ordinary unfavourable conditions of the track due to the weather.

A recent report of a large railway shows that an increase of *one-fifth of one car* per train brought an increased revenue of over \$50,000 in six months. It is needless to say, therefore, that if the claims made by the Ries Electric Traction and Brake Company for their traction-increasing system are even partially realised in practice—and the experiments already made by Mr. Ries go to indicate that these claims are entirely within the mark—the increased earnings to railroads from the use of this invention would be simply enormous, to say nothing of the operating and other advantages to both steam and electric railways that would result from its adoption.

## PARLIAMENTARY NOTES.

### THE DUBLIN SCIENCE AND ART BUILDINGS.

IN the House of Commons last Thursday night, in answer to Mr. P. O'Brien,

Mr. JACKSON said: Four firms were invited to tender for lighting the New Science and Art Buildings in Dublin by electricity, viz., Messrs. Siemens Brothers and Co., Messrs. Johnson & Phillips, Messrs. Edmundson & Co., and the Brush Company, and tenders were received from the three first named. Messrs. Edmundson's tender for £8,375, being the lowest, was accepted; the contract with them contains no stipulation as to giving a preference to any firm.

### USE OF TELEGRAPHS BY THE FISHERY BOARD.

During the debate on Supply last week, Mr. DUFF, in the course of a speech, complained of the action of the Fishery Board in taking from the surplus herring brand fees £1,500 for the extension of telegraphs. He did not deny that the telegraphs were of great importance to the fishing community, but he contended that they were used for Imperial purposes.

The LORD ADVOCATE in his reply stated that the application of the money of the fund to telegraphs had been described as a grant in aid of the Imperial expenditure, but he would point out that it was not a correct way of describing it, because it was merely aid given to the fishing harbours for telegraphic purposes.

### DIRECTORS' LIABILITY BILL.

In the House of Lords, on Friday night, Lord HERSCHELL, in moving the third reading of the Directors' Liability Bill, explained and vindicated the alterations made in the measure by the Standing Committee of their lordships' House, contending that, instead of weakening and maiming the Bill, as some critics had alleged, they only tended to render it more easily workable and effective. He, however, expressed his regret at the adoption in committee of the whole House of the Lord Chancellor's amendment in respect to responsibility for the statements of experts—a change which, he thought, involved considerable danger.

The Lord CHANCELLOR defended his action in regard to the Bill, asserting that his only object had been to make it, if possible, a reasonable and workable measure.

After some remarks from Lord BRAMWELL, the Bill was read a third time, and, having then undergone some verbal amendment, it was passed.

### LIGHTHOUSE ILLUMINANTS.

In the House of Commons, last Friday, Mr. T. W. RUSSELL asked the President of the Board of Trade whether the committee of the Royal Society appointed to inquire into the report on lighthouse illuminants

had sent in their report, and, if not, when it might be expected.

Sir M. HICKS-BEACH: I understand from the president of the Royal Society that the committee on this subject do not propose to have any further interviews, and that their report is partly drawn up, but it seems doubtful whether it will be finished before the prorogation.

### THE LIGHTING OF THE HOUSE OF COMMONS.

Sir G. CAMPBELL asked the First Commissioner of Works if he would arrange before next session to put shaded electric lights in the roof of the House, so as to save members from the heat and glare of the gas in the long winter nights, and make the nearest possible approach to daylight.

Sir H. MAXWELL said the electric light was tried some time ago in the roof of the House, but the results were not satisfactory. The present gaslights were connected with the ventilation, and it would be inconvenient to dispense with them.

### TELEGRAPH CLERKS.

Dr. FARQUHARSON asked the Postmaster-General whether any steps were being taken to redress the grievances complained of by the clerks of the Central Telegraph Office as to the extra hours without equitable remuneration for what are known as long and short duties.

Sir H. MAXWELL (on behalf of Mr. Raikes): In reply to the hon. member, I have to state that much attention has been given to the duties referred to, with every desire to lighten their incidence, but no one, either on the part of the Post Office or on the part of the officers themselves, has been able to suggest any practicable scheme for getting rid of these duties. This matter formed an element of consideration in improving the pay under the scheme recently issued.

### DUBLIN TELEGRAPH DEPARTMENT.

In answer to Mr. MacNeill,

Sir H. J. MAXWELL said: The question of revising the salaries of the Dublin supervising staff will be considered as early as possible in connection with similar questions elsewhere, but it is improbable that improvement, should improvement prove to be necessary, will take effect from a date anterior to that on which the authority of the Treasury is given.

## THUNDERSTORMS.

A TYPICAL thunderstorm, writes Mr. H. A. Hazen in *Science*, is first seen as a dense, ragged cloud in the west, extending to a height of over a mile. The sky is entirely clear elsewhere, except sometimes covered by a light fleecy veil of cirrus. The cloud in the west rapidly enlarges, and completely covers the sky except a small portion to the east and south-east. The motion of these clouds is distinctly from the west and quite rapid, while the surface wind is from the south and quite gentle. This wind is blowing toward a general storm situated about 500 miles to the north-west, and has no connection at all with the thunderstorm, which is suddenly, interjected, as it were, upon the quiet air. Often there are seen two clouds in the south-west and north-west which seem to meet together and produce the storm, but more often the first appearance is that of a great cloud of dust borne upward about 300 feet, and advancing with great rapidity from the west (sometimes 80 miles per hour). Some of the clouds sprinkle a little rain as the dust-cloud advances, but this is very light. When the storm is very severe, a loud roar is heard like the continuous discharge of electricity, which produces a steady instead of intermittent thunder. During this time, lightning-flashes are seen and distant thunder heard. In a few moments, after the dust-cloud has approached nearer, and practically with it,

the wind suddenly whirls to the west, and blows with great velocity (sometimes 80 miles per hour). Then, in a moment or two more, the lightning and thunder become very intense, and rain falls in torrents. Often the lightning's flash is the signal for a fresh downpour, allowing a few seconds for the fall of the rain from its height. This phenomenon has led to the view, now almost universally accepted, that there is a most intimate relation of cause and effect in this display of electricity and the subsequent rain. Under some circumstances, but invariably in connection with this heavy rain, there fall hail-stones variously measured from the size of a pea to that of hen's eggs, and even larger. In some cases, larger masses, even as great as an elephant, have been reported, but these are due to a mingling or freezing together of many stones in the air or after they reach the earth.

During the progress of a thunderstorm, and after its front has reached the observer, there is a remarkable cooling of the air. This cooling seems to arise from a downward current in the centre of the storm. It cannot be due to the onrush of a north-westerly wind, for that must come from a warm region, since the thunderstorm has been suddenly interjected into a region of warm southerly winds flowing for hundreds of miles toward the north. This cooling is often very great, and seems to indicate that the air in the centre of the storm is not abnormally heated, as in the case of a general storm, but is very much cooled. The bearing of this upon the generation of the thunderstorm is of great importance, and does not seem to have been sufficiently considered.

When the storm passes to the north or south of the observer, there is quite a brisk breeze from it, showing that the motion of the air is from it on at least three sides. Often it is possible to view the storm, in its onward progress, with clear sky overhead, if its border does not reach the zenith of the observer. Under these circumstances, one sees very distinctly up to the highest clouds a steady motion to the east. The rain is seen falling in great sheets, and its front is very distinctly marked. This rain front seems to be an important phenomenon, and has been seen scores of times advancing with a slight lagging at the earth and in the clouds. The appearance impresses one at once as caused by a rapid motion in the middle cloud region, with a lagging at the earth possibly from friction, and in the upper part of the cloud from a less velocity at that point. In no instance has there ever been observed an uprush of air anywhere in this region. These storms go in parallel lines, and as many as four have been seen running one behind the other, the most northerly one in advance. Often it is reported that a storm has gone slightly north of a station, and then turned and come back directly over it; but this is probably an illusion. The second storm has a motion the same as the first, but goes a little farther south. The motion across the country of these storms is about double that of the attending general storm to the north-west.

Probably the most marked characteristic of a thunderstorm, however, is a rise in pressure at its centre. This rise is universally conceded to-day, though its cause is in grave doubt. It has been repeatedly observed in storms where there has been no rain, and hence cannot be due to the cooling of the air by the rain, or to its downward pressure as it falls. How is it possible to account for this rise of pressure in a storm which is itself travelling more than a mile a minute? We have here to consider a phenomenon entirely distinct from a sand-whirl of the desert, which has only a slight progressive motion. There seems to be no doubt whatever that we are to consider here a cause or a condition which is inherent in the storm itself. There can be no upsetting of the equilibrium, no uprush of air just in front of a thunderstorm and nowhere else, which could give such a rise of pressure in so rapidly a moving body of air. We are certainly dealing here with a *plenum* which moves with the storm, and, in fact, is the storm itself. It may not be that this is due to a downrush of air particles from some height; but there is no serious difficulty in assuming that, through

electrical action, there is an increased pressure in the centre. It is plain that the foregoing description has a most marked parallelism with that already given of the tornado, and it is virtually admitted that a tornado is simply an extreme development of a thunderstorm.

The attempt to show that while these phenomena are alike in most respects, and yet that in one of the more important factors they are entirely distinct, is most remarkable. We are taught that the origin of both is an unstable equilibrium, in both there is an uprush of air, in both there is a cloud of dust, in both there appear to be two clouds meeting from the north-west and south-west, in both there is a loud roar heard oftentimes, and in both there is a pronounced cooling. They are exactly alike, and produced the same way, but the final result of these actions is to develop two entirely dissimilar and almost opposite conditions. We are told that in a thunderstorm the air starts upward in the centre, has its moisture condensed by expansion, and the resulting precipitation cools the air, increases its density, and finally the diminished pressure at starting gives way to an increased pressure from this change in the density. It must be admitted that this is a reasonable conception, and may be true; but would not this at once destroy the ascending current, and bring the whole action to a standstill? Can we for a moment have both uprushing currents in a storm centre feeding its energy, side by side, with downrushing currents increasing the pressure? It is only necessary to state this contradiction in order to show the absurdity of the hypothesis. This theory strikes at the root of the whole process of liberation of energy in a moist ascending current; but more than that, if there is such a cooling and subsequent downrush, why should it not act in precisely the same manner in a tornado? How is it possible for this same uprushing current, which starts in exactly the same way in both these conditions, to continue upward in a tornado, to gather energy as it rises, to liberate more and more latent heat, to rush faster and faster, to grow warmer and warmer, and finally to produce the violent tornado with its supposed almost perfect vacuum in the centre, where a half-mile away there is perhaps a thunderstorm causing an increase of pressure? It would seem as though there could hardly be a plainer exposition of the utter futility of all the attempts that modern theorists have made to grapple with this problem, than this latest attempt to start the thunderstorm and tornado in the same direction, and finally bring them out, from almost the same conditions, facing in opposite directions, and absolutely dissimilar in their most essential characteristic.

Is it possible for electricity to produce a sudden increase of pressure in a mass of air sufficient to violently rend asunder objects which it strikes? Oftentimes the bark of trees has been driven off; and the usual explanation of this has been, that the heat of the electricity has converted the sap into steam, and this in turn has forced off the bark. This, however, is not satisfactory, for the reason that even a dead and perfectly dry tree has been struck, and scattered over a large field. A remarkable instance of explosive action in a lightning discharge is to be found in *Nature* for May 8, 1890. A tree standing in a rather open field was struck by lightning, and its fragments strewed over two acres of ground. One solid piece, weighing  $5\frac{1}{2}$  pounds, was thrown 378 feet. Other *débris* lay 210 feet in another direction. Small pieces of riven trunk and bark were found thrown in the teeth of the wind and 180 feet from the tree. The concussion or increase of pressure smashed six fine glass window-panes in a house not far away. Another very interesting effect was noted in a house that was struck in Washington, D.C., August 23rd, 1885. In this case the lightning struck the south-west corner of the tin roof on an ell built on the south side of the house, and divided. A portion of the flash passed down an eaves-spout; and at its end, which was two or three feet above the ground, it passed through the air to the damp side of the house, knocking off the plastering on the inside. The other portion of the flash passed down between the weather-boarding and the plastering on the east side

shattered one of the upright posts, and appeared to explode off the weather-boarding toward the east, and the plastering toward the west. A woman and her two sons were apparently stunned by the effects.

While such cases have usually been regarded as "freaks" of lightning, yet it would seem that the matter has not been sufficiently studied to enable us to determine just what effect such a discharge would have upon a confined air space. It may be, the apparent bursting of a house in a tornado may be accounted for in this way. An instance has already been given at St. Louis of a rise in pressure, as shown by a barograph, and at the same time a seeming bursting of houses. Hardly a month passes that there is not some discovery regarding this extraordinary force of electricity, and surely we are not in a position to deny that it might not produce a large number of effects now observed in a tornado, such as searing of green leaves, discolouring the trunks of trees, increasing the pressure, exploding houses, depluming fowls, &c. We are told that lightning flashes are seldom seen in a funnel cloud. They have been seen there many times. Moreover, it is not at all certain that an ordinary observer would be in a condition to take particular notice of the presence of electricity in a tornado; and, again, the electricity may pass down or up the funnel without a visible flash. The presence of ozone has been often noticed in a tornado where no lightning was seen.

It has been my purpose for many years to avoid, as much as possible, all speculations in considering air motions and the causes of atmospheric phenomena. This is especially pertinent when we consider electric action in the atmosphere. It is very difficult to believe that electricity has nothing to do with our thunderstorms, and is merely a result, and never a cause. The fact that physicists have never yet been able to account for more than the smallest fraction of atmospheric electricity should lead us to greater diligence in determining its methods. We know from observation that the electric potential is enormously increased as we ascend in the atmosphere. That little or no connection between atmospheric electricity and storms has been observed by our instruments near the earth is not remarkable, since the earth and air just above it may neutralise all electric action for a hundred feet or more. Our thunderstorms seem to show an enormous storehouse of electricity at five thousand or six thousand feet above the earth; at least, electricity seems to be concentrated there over thousands of square miles during thunderstorm action. We are taught that electricity forms a sort of dual condition, or the electric field is a double one. May not this electric field draw on the sun for its energy? It is believed that light, heat, and electricity are all different manifestations of the same radiant energy. The abundant source of this energy is the sun. Why may not the sun's electricity, oftentimes observed by its direct effect on our magnetic instruments, and more often still indirectly in our auroras, be intercepted by a peculiar condition of the atmosphere or of the earth below, and thus be concentrated in particular localities? Generally this electricity passes through the air to the earth, but must we think that it always does so? May not this electric field or dual condition gradually develop in the atmosphere largely independent of the passage of air particles through wind or convection currents?

For convenience it has been generally considered that particles have a tendency to leave the positive and pass to the negative pole. For example: in the electric arc light the carbon at the negative pole is built up at the expense of the positive. The velocity of transmission of these carbon particles perhaps cannot be determined, but it must be only a very small fraction of that of electricity, 190,000 miles per second. Is there any inherent improbability in the supposition that in this dual condition in the atmosphere there is a tendency for moisture and possibly dust particles, positively electrified, to pass rather rapidly from the positive pole, or, better, positive portion of the electric field, to the

negative portion? We know from observation that during the passage of a high area or clear sky the electric potential, with very few exceptions, becomes markedly positive, while during the fall of rain it is negative. While a thunderstorm is passing, there are most violent fluctuations of the electrometer needle from negative to positive and back again, as each flash of lightning is noticed. These fluctuations of the needle are perhaps a hundred times as great as under ordinary conditions of rainfall, and take place when the flash is a mile or two away, showing a most extraordinary inductive action upon the atmosphere, and for enormous distances. We have positive evidence of such transmission of moisture particles by a force entirely distinct from heat, pressure, or any other commonly recognised meteorologic condition. It is known that the moisture in the air is one of the most constant elements we have to deal with. The temperature may rise and fall thirty or forty degrees during the day, and yet the quantity of vapour is in no wise changed. The wind, either in direction or velocity, does not change this moisture. The hiding of the sun's heat or light in no wise affects it. Changes in air-pressure produce no effect in general. As a storm approaches, however, we find a most marked increase in this moisture over thousands of square miles, and this even in a calm. As a storm passes off, the conditions are sharply reversed. The moisture becomes depleted in a most remarkable manner, as though it were actually drawn out of the atmosphere by an invisible agency.

The most remarkable example of such action was observed on December 22nd, 1889, from a third-story window of a house in Washington. It will be seen that the conditions were not favourable for observing this effect at its best. At 3.11 p.m. there were 4.09 grains per cubic foot, and for more than 24 hours previous there had been an abundance of moisture from a storm passing near by. The air was almost a calm, and continued so till nightfall. At 5.2 p.m., or 111 minutes later, there was only 1.04 grain per cubic foot, and this continued as long as observed. To any one who has made determinations of the moisture of the air, and noted its great constancy, frequently for several days, this sudden subtraction must be very extraordinary. If such changes are possible near the earth, and in the centre of a large city with houses for more than a mile on all sides, what may we not expect to take place in the free air, where there are no interferences, and where we know that such forces are acting in far greater intensity than near the earth?

Just after a thunderstorm or tornado there are torrents of rain, and in some quarters it is getting to be quite the custom to call such phenomena cloud-bursts. In these cloud-bursts almost an incalculable amount of rain falls, more than a foot having been reported at times. In one case 4 feet of hail were reported. Just how much territory is covered by such a cloud-burst cannot be told, as the data are not sufficiently numerous, but 50 or 60 square miles may be easily considered. We have already seen that the later theory, which calls for a downrush in the centre of a thunderstorm, effectually disposes of all possibility of this enormous amount of moisture rushing up in the centre and being condensed by expansion. In the case of a tornado, it is incredible that even a thousandth part of this moisture can be carried up in a funnel a few hundred feet in diameter. If we inquire what would be the effect of the ordinary condensation of such a mass of water in the air over such a limited space, we are confronted by an amount of heat set free that is simply appalling. One gallon of rainfall gives out sufficient heat to melt 45 lbs. of cast iron. A very little consideration will show us that it is absolutely impossible, even allowing a current of moist air at any conceivable velocity, for even a small fraction of rain to be precipitated out of such a current. It has already been shown that the latent heat set free would at once re-evaporate the moisture. We seem to be driven to invoke the aid of some other agent than any thus far recognised as cogent in producing our storms. Is it inconceivable that we have to deal here with a negative

electric field, which draws to itself with great velocity particles of moisture from regions perhaps for 100 miles about, when suddenly, upon a discharge of electricity, the potential upon the particles is diminished, and they unite in great abundance and form raindrops? This is a most inviting field for observation. We already have facts enough to make a plausible hypothesis, and, what is very important, we have here an unlimited amount of energy which may be called upon to produce all the effects ever observed.

It is not a little remarkable that the earlier views all ascribed tornadic action to electricity, and it would seem as though the time were not far distant when we would be forced to return to this agent for explaining the phenomena. What are needed are careful experiments in this most enchanting field of research. An attempt has been already made to test the question of the transmittal of moisture through the air by electric action. A Holtz machine was run for 15 minutes in a rather large room; and most careful measurements of the amount of moisture at the machine and at a point 20 feet away, before and after the machine was in action, showed an increase at the machine. When we consider that it was impossible to measure the moisture contents just at the plate of the machine, and also what an extremely slight charge could by any possibility enter the air from the machine, we can but be surprised that any effect at all was observed. With improved methods of observation by which the exact hygrometric state of the air can be easily and accurately determined, and with very accurate tables of reduction which we now have, all that is required is an observer for investigating these phenomena. The expense for apparatus need not be great.

SHIP LIGHTING PLANT.

DURING the visit of the members of the Institution of Electrical Engineers to Edinburgh, Dr. Walmsley read a paper on "Some Chief features, mainly Electrical, of the Edinburgh International Exhibition, 1890." In the section devoted to electric lighting, there appears the following paragraph, which, with the table mentioned, we here reproduce:—

Considering the position of the exhibition, it is but natural that most of the exhibitors of dynamos and engines should include a set of ship lighting plant amongst their other exhibits. For the convenience of those visitors who are interested in this branch of electrical work, I have embodied in Table A a few particulars of

the different combinations that are open to their inspection. In the last column I have calculated as being of some interest the number of watts available in the outer current per square foot of floor space occupied. Of course, I do not mean to imply that this is the only or even the most important thing to be considered in selecting ship lighting plant, but it is interesting as showing what can be done in this direction. In comparing these numbers the steam pressures given in another column must not be overlooked.

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

The following discussion took place on Mr. BENNETT's paper on "Foreign Currents," read at the Edinburgh meeting.

After the CHAIRMAN had proposed a vote of thanks to Mr. Bennett for his paper,

Mr. W. H. PREECE said he had been asked to supplement the remarks that Mr. Bennett had made, as regarded foreign currents that were traced, and were found not only in arial conductors but in other conductors. The phenomena that Mr. Bennett had brought before them was, he thought, indicated in Fleming Jenkin's book on electricity, where he showed that with an insulator, in wet weather, there must be currents of polarisation, i.e., the currents passing through by leakage—the moisture from the insulator decomposes the water in its constituent elements and the formation of gas must produce these currents of polarisation. Practically these currents did not produce any serious detriment on their telegraphs. There was no doubt that the transmission of signals in wet weather was slower, more sluggish than in fine weather, due to these causes. But there were other currents found in the wires not traceable on telegraphs, but very readily perceptible on telephones. He did not know whether any one present had amused themselves, as he had done by spending a whole night in a telegraph office with telephones to his ears, tracing the effect of the foreign currents. The sounds were sometimes most remarkable. Occasionally they heard a slight scream, not unlike a scream of pain from a child. At other times sounds were heard which had been likened to a cry of a young bird. One explanation given was that as the wires swing across the lines of force of the earth, there was an electromotive force set upon these wires, and when there was a long swing there might occasionally be a summation of all these vibrations that would produce a succession of currents resulting in these peculiar sounds. There was a very troublesome source of foreign currents on their wires, due to the introduction of the alternate current system of generating the electric light. That occurred in the case of the London Electric Supply Corporation, who had given the Post Office very evident cause of their presence down at Deptford, in fact, most of their wires to the South had been more or less disturbed, and so great was the disturbance at one time, that it was felt at Paris. There was another source of disturbance due to the working of the tramways. It was felt at Blackpool, for instance, in the

Exhibitor.	Englue.	Steam pressure.	Speed.	Dynamos.	Kilowatts in outer circuit.	Floor space.	Watts per square foot of floor space.
King, Brown & Co. ....	Compound vertical 7½in. x 12in. } 12in. x 12in. }	120	300 {	King, Brown & Co.'s four-pole, compound wound .....	41	8ft. 6in. x 3ft. 0in. = 25ft. 5in.	1725
King, Brown & Co. ....	High pressure vertical 6½in. x 6in.	160	285 {	King, Brown & Co.'s single magnet, compound wound .....	12.6	5ft. 6in. x 2ft. 9in. = 15ft. 1in.	834
Ernest Scott & Co. ....	High speed vertical 6½in. x 6in.	80	380 {	"Tyne" slow speed compound wound ...	4.8	6ft. 0in. x 3ft. 0in. = 18ft. 0in.	267
Brush Electrical Engineering Co. ....	High pressure vertical 8in. x 6in.	80	300 {	Victoria, compound wound .....	6.5	6ft. 0in. x 2ft. 8in. = 16ft. 0in.	406
India Rubber, Gutta Percha, and Telegraph Works Co. ...	Globe compound automatic vertical 8½in. x 8in. } 15in. x 8in. }	100	300 {	Silvertown, single magnet, compound wound .....	36.75	9ft. 10in. x 4ft. 3in. = 41ft. 8in.	872
Napier, Prentice & Co. {	Either compound 4in. x 5in. } 8in. x 5in. } or two high pressure horizontal	100 } 50 }	550 {	Napier-Prentice double magnetic circuit, two pole .....	11.0	... = 31ft. 0in.	355
Norman & Son .....	Sabberton Bros.' high speed vertical 6in. x 9in.	80	260	Laurence, Scott & Co.	4.5	5ft. 6in. x 2ft. 8in. = 14ft. 8in.	304
Norman & Son .....	Single acting cylinder 3in. diameter	60	...	Laurence, Scott & Co.	0.48	2ft. 3in. x 1ft. 2in. = 2ft. 6in.	185
E. S. Hindley ...	High pressure vertical 7in. x 8in.	60	...	Phoenix .....	5.2		

taking up and setting down of passengers. Most of these that he had referred to were foreign currents due to effects—very well known effects of induction, easily measured—carried to immense distances. The phenomena Mr. Bennett had brought before them were really electro-chemical, due more to the ordinary elementary principles associated with the ordinary construction of batteries, and although they might be interesting, he did not think they were very serious. He thought if they had the slightest influence on the speed or accuracy of the work of the telegraph it would not have taken them forty years to secure evidence of their existence.

Mr. HEAVISIDE, Newcastle, said that in his district they made use of the effects to which Mr. Bennett had referred in their insulators. They were constantly removing iron wire and placing copper wire on the poles. The iron wire left behind it oxide of iron, and when they placed copper wire in position they gradually got the effects mentioned by Mr. Bennett.

Mr. BENNETT stated in reply that the effects he had brought before the Conference were entirely wet weather effects. Those mentioned by Mr. Preece were mostly noticeable in dry weather. Although the voltaic action, and polarisation of the bolts had not hitherto been noticeable, he thought the effect was due to the use of iron wire exclusively. Recently copper was replacing iron all over the country, and the results noticed hitherto might be expected to increase considerably. Respecting the disturbance which might be expected from a more extensive introduction of electric tramways, a gentleman from Boston who was in Edinburgh recently, had told him that they did not hope to make any great use of the telephone system after nine o'clock at night, owing to the fact that the electric light in Boston came into operation after that hour. The telephone system was very much worse now than before the electric tramways were introduced into Boston. The fact was very serious indeed, and had given rise to endless litigation between the Telephone Company and the various tramway companies in the States. This was a matter they must endeavour to guard against in this country. It must be done in one of two ways, either by compelling the Tramway Company to use metallic circuits everywhere, or by the Telephone Company using them themselves. (Applause.)

The Conference then adjourned, and the members, after lunching, were conducted over the Exhibition, devoting their attention specially to the electrical sections.

#### DISCUSSION ON PROF. AYRTON'S PAPER.

Mr. PREECE, who occupied the chair when Prof. Ayrton's paper was read, called upon Prof. Perry to open the discussion.

Prof. PERRY said it was impossible for them to be prepared to discuss a paper on so short a notice, a paper which had taken years of work. It completely transformed their old notions. He was astonished at the large working efficiencies that had been obtained. It seemed to him a thing of enormous importance that those observations had been made by those who had absolutely no pecuniary interest in the matter. He had no doubt that makers were perfectly honest, and the results they gave were fair, but he liked to have an utterly independent set of observations. He admired the ingenuity which had been shown in the designing of the apparatus for keeping the current absolutely constant during charge or discharge, at the same time it might appear to him as a personal waste of energy. It seemed to him a terrible thing that such an enormous amount of thought should be devoted to work simply for the general good of the profession, and not at all for the general good of the authors of the paper; he was sure that they had exceedingly little to gain, compared with the enormous amount of work.

Mr. KAPP expressed himself pleased with the efficiencies of the cell, he would, however, suggest that the discussion should be continued at the next ordinary meeting of the Institution, when everybody would have read the paper, it would receive the discussion it deserved.

Lord BURY said he had employed secondary batteries to a very considerable extent and had put them to searching practical tests, the result of which was that they could be relied up to a greater extent than was generally believed. There were many improvements now being made in the practical development of these cells, one of which had been lately initiated by his friend Mr. Barber Starkey (See ELECTRICAL REVIEW, July 18th), by which the rough usage to which they were subjected in the course of tramway traction, could be very much counteracted.

Mr. FRASER gave an account of some experiments which he had carried out three years ago in regard to the variation of resistance in relation to current. He was favourably impressed with the method adopted by Mr. Barber Starkey, but he would wait until the end of the life of cells to see proof of their superiority. After remarks by M. Hospitalier and Mr. Swan,

Mr. PREECE considered, before he called upon Mr. Smith to reply on behalf of the authors, it would be only fair to them that he (the Chairman) should make any remarks he had to make. He was bound to confess that at the present day there was no subject of greater importance to the electrical engineer than that of the proper performance of secondary batteries. They were coming into use more and more every day, not only for the comfort of those who have their houses lighted by electricity, but for those who travel by railway trains. In every branch of electrical engineering secondary cells were being used. The speaker dwelt upon the fact that there was a great prejudice against the use of

secondary batteries, and it was based on the supposition that they were very inefficient. Though a few of them had long felt that the battery was not quite so efficient, the majority would feel that the authors of the paper had done a great work indeed throughout the profession, the unmistakeable figures before them showed that a secondary battery was not a very inefficient machine. Again, it had an important bearing on the question of distribution of electricity over large areas. The favourite system at the present was to distribute currents over wide areas by means of alternating currents and secondary generators, but there were those who believed in the future of secondary cells and who thought the day was not far distant when secondary batteries would knock out of the field the secondary generator. He, the speaker, was not one of those. He firmly believed in the secondary generator. One great drawback, however, in this system, had been their very low efficiency, and this was attributed to the inefficiency of the battery. He had very good reason to think that it was due not to the secondary cell itself, but to the methods which were adopted to charge and discharge the cells. In connection with this there was a fallacy which was very widespread, and it was, that because in charging a secondary battery they work up to an E.M.F. of 2.4 or 2.5 volts, and in discharging, you get down to about 2.1 volts, therefore there was a loss of efficiency of 25 per cent. in the battery; it was one of the most absurd fallacies ever perpetrated, and its fallacy was shown by the tables of the makers of secondary batteries; it is perfectly theoretically possible to get as much out of your battery as was put in, but practically it is not so. One of the most important features of the paper showed that necessarily there was a loss of energy in the cells owing to the action at the surface and diffusion of energy into the surrounding atmosphere. Practical men had arrived at very much the same conclusions as the authors of the paper. It had always been satisfactory for them to find that their conclusions had been borne out by accurate scientific investigations. They had long ago come to the conclusion that the E.M.F. of a cell should never be allowed to fall one point. He referred to the use of cells in his own house, which had been there for several years, and he had not had the slightest flicker of the light, which was entirely owing to the fact that the cells had been treated as secondary cells should always be treated, with great care and consideration. Cells which they had in the Post Office six years ago were still in existence. He (the speaker) had never yet succeeded in breaking or using up a single cell he ever had in his possession. The first cells he had were the Elwell-Parker type of Planté. They had tried all the types of E.P.S. which were in existence, in his own house. He liked them at home to experiment with, and if anyone would submit a battery cell, he would not hesitate to replace them and give them practical tests. Practice had introduced another test, one of great value indeed, and he would continue to call most earnest attention of those who wished the cell to prosper, always watch the performance of the electrolyte, never mind the E.M.F.; take care of the internal resistance, and to measure the density of the liquid by means of a hydrometer. In his room at the Post Office a book is kept recording the density and performance of every cell, and they could tell at once how a cell was behaving. Mr. Barber-Starkey had referred to the fact that he had introduced soda into his cells. He (the speaker) was very much struck, when visiting that gentleman, to see in what beautiful condition his plates had been brought to, and he was shown it was entirely due to the use of soda. Mr. Starkey applied it in a very rough-and-ready kind of way, he bundled some carbonate of soda into the cell and there remained sulphate of soda, which mixed with the cell. He (the speaker) was so well satisfied that there was so much in this that he organised a long series of experiments, lasting for nearly two years, to determine the proper proportion which should bear between the use of soda and sulphuric acid, and the conclusion arrived at was as follows, the solution was tried in the E.P.S. type, which is a cell taking 45 pints of electrolyte, made up of 39 pints of water, 5 pints of sulphuric acid of the highest specific gravity, and 1 pint of saturated solution of sulphate of soda, and the plates looked as bright and as beautiful as one could wish them to be. In conclusion, the speaker said the apparatus used by the authors reminded one of that brought two or three years ago before the notice of the Institution by Mr. Edmunds.

Mr. SMITH, on behalf of the authors, briefly replied, and the meeting adjourned.

#### NEW PATENTS—1890.

11788. "Improvements in electric arc lamps." S. P. PARMLY. Dated July 28. (Complete.)

11817. "Improvements in electric light fixtures." F. H. ALDRICH. Dated July 29. (Complete.)

11862. "Improvements in electrostatic measuring instruments." W. E. AYRTON and T. MATHER. Dated July 29.

11863. "Improvements in electric switches." W. W. STRODE and C. G. GILL. Dated July 29. (Complete.)

11883. "Improvements in the distribution of electricity, and in the apparatus employed therein." T. TOMLINSON. Dated July 29.

12009. "Improvements in electric indicators and in bells, applicable also to other purposes." J. S. ROSS. Dated July 31.

12094. "An electric fuse for firing guns." R. MORRIS. Dated August 1.

12119. "An appliance for holding the brushes of dynamo-electric machines while being repaired." H. HOLLINGDRAKE. Dated August 2.

12169. "Improvements in and relating to apparatus for measuring electrical energy." L. A. W. DESRUILLLES and R. F. O. CHAUVIN. Dated August 2.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

4484. "Improvements in the regulation of electric currents." W. M. MORDEY. Dated March 14. 8d. Relates to the use of a small apparatus which the inventor calls a corrector, resembling a transformer in construction, and consisting of a suitably laminated iron core or sheath provided usually with two coils of wire. The corrector is wound with two windings, one of comparatively fine wire, which is connected as a shunt to the secondary terminals of the transformer, and thus is in parallel with the lamps. The other coil is of a thicker conductor, and has a smaller number of turns, and is connected in series with the lamps—that is to say, it is connected between one of the secondary terminals of the transformer and one of the secondary mains, the other secondary main being connected directly to the other secondary terminal of the transformer. The shunt winding may be connected across the secondary and the series winding combined, that is across the lamp terminals, instead of to the secondary terminals. The two circuits of the corrector are arranged to be traversed by currents in the same direction. The shunt or fine wire winding of the corrector, which is called the initial winding, is designed so that when connected to the transformer alone it receives such a current that the iron receives a certain initial magnetisation. In this condition the corrector opposes a certain impedance, opposing E.M.F., or choking action to any small current through its series winding, the effect, when a small number of lamps is switched on, being to reduce the potential difference available in the secondary circuit, to a value somewhat below that existing at the secondary terminals of the transformer. On the passage of a larger current in the secondary circuit, as when more lamps are switched on, the opposing E.M.F. or choking action of the corrector becomes reduced on account of the saturation of the iron, and a larger potential difference is made available in the secondary circuit. This effect is produced with only a trifling expenditure of energy, and the corrector is not to be taken as equivalent in this respect to a resistance. 2 claims.

6520. "Improvements in or relating to electrical motors for clocks and similar apparatus." W. P. THOMPSON. (A communication from abroad by Günther and Louis Hoppe, of Germany.) Dated April 16. 6d. Has for its object a motor in which the power of an ordinary or permanent magnet is utilised to actuate a vibrating arm in one direction in such a manner that on the end of its stroke an electric circuit shall be automatically closed, which energises an electro-magnet, the power of which is used to return said vibrating arm. The arm being thus vibrated, the clock or other mechanism is actuated by means of suitable connections. 2 claims.

7796. "Improvements in supporting electric conductors." W. A. S. BENSON. Dated May 9. 6d. The inventor binds together the insulated conductors forming part of an electric circuit or part thereof by a wire or wires wound spirally around them, which wire gives an ornamental appearance to the conductors, and lessens risk of the conductors becoming injured. In order to take any longitudinal strain, he lays wires parallel to the conductors and within the spiral binding wire. Upon the outside of the conductors he passes a tube, screw-threaded on the outside; this tube is slotted to receive the longitudinal supporting wires and the end of the protecting wire, which are passed through inside it and turned backwards in the slots, a cap or outer tube is then screwed on, whereby the longitudinal wires and protecting wire are firmly held. This cap or outer tube has attached to it a disc or bracket to be fixed to the wall, ceiling, or other place from which it is desired to suspend the conductors. 2 claims.

7883. "Improvements in electro-motors and apparatus used therewith for dental and other purposes." T. CUTTRISS. Dated May 11. 6d. Consist of an arrangement for instantly stopping the rotation of the burr, drill, stone, or other tool actuated by the motor, by making use of an electro-magnet for actuating a clutch arrangement attached to the motor, the current for working the electro-magnet being preferably obtained from the same source as used for driving the motor. 2 claims.

8030. "Improved automatic switch for charging electric accumulators and like purposes." M. E. UNGER. Dated May 14. 6d. A disc of insulating material is mounted on a shaft revolving in bearings. Around the disc are a set of metallic coatings, corresponding to the number of contact connections to be made. The coatings are insulated from one another step like on the disc, their number being one more than the number of the series. On the disc there are also places not coated with metal which correspond to the several segments of the contacts. The contact surfaces are

passed over and alternately rubbed by springs in communication with the source of electricity, and which conduct the current to the metallic coatings from which proceed short metal strips, and from these latter short wire connections to contact rollers fixed insulatedly on the same revolving shaft as the disc. The rollers rotate in quicksilver vessels, insulated from one another, and in which dip springs that are in connection with the corresponding poles of the series. The uncoated parts of the disc serve upon the sliding off therefrom of the springs to interrupt the current from the contact surface in connection with the last negative pole of the series, until upon the further turning of the disc a spring once more comes in contact with a contact surface in connection with the negative pole of the corresponding series, so that by this means short circuiting between the poles of the secondary batteries is prevented. 2 claims.

8692. "Improvements in multiple switch board systems for telephonic exchanges and wire bands to be used therein." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company of Chicago.) Dated May 24. 8d. The object of this invention is to dispose the wires at the rear of the switch board in such a manner that they may be spread out to the rear without occupying an undue amount of vertical space, and at the same time to change the positions of the different wires relatively one to another as they pass from section to section, so that no two telephone wires may remain in close proximity to one another for any considerable distance. This is effected by making up or weaving together the wires into flat bands, preferably of a depth of a single wire only. 7 claims.

9119. "Improvements in electric bells and indicators." E. T. FIFORD. Dated June 1. 6d. Consists of a pendulum, suspended in front of the bell from a stud or bracket. A small soft iron armature is fixed on the pendulum rod opposite the pole of an electro-magnet attached to the bell frame. When a current is sent through the bell coils, it also passes through the coil of the aforesaid electro-magnet, and attracts the pendulum; as soon as the bell stops ringing the pendulum is released and swings, indicating that the bell has rung. 4 claims.

9133. "Improvements in the manufacture of carbons or electrodes for electric lamps." H. H. LAKE. (Communicated from abroad by Messrs. Lacombe & Co., of Paris.) Dated June 1. 6d. The inventor places between discs or other pieces or layers of carbon a layer of a material composed of a mixture of carbonaceous and silicious substances, or any suitable composition or material which, while not interfering with the proper working of the lamp, will by reason of the better conduction of the electrical current ensure the retention of the arc in a fixed position, and the consequent steadiness of the light. The pieces or layers of carbon, with the steady substance above mentioned between them, are preferably subjected to a high degree of compression so as to consolidate the mass, and increase the density and homogeneity thereof and the duration of the electrodes. 5 claims.

9162. "Improvements in the armatures of dynamo machines." C. E. L. BROWN. Dated June 3. 8d. Claims:—1. The construction of a drum wound armature, in which the wires between which the maximum difference of potential may exist are completely separated over the whole armature and throughout their length by an interposed continuous sheet of insulating material, one half the wires lying at one side of the said sheet, and the other half at the other side. 2. The improved method of winding and insulating the wires of drum armatures, substantially as described with reference respectively to and shown in the drawings.

9304. "Improvements in switches for electrical purposes." W. BARNICOAT. Dated June 4. 6d. The inventor arranges segmental opposite plates on the base of the instrument, which are secured thereto by a screw, the said screws also clamping the terminal wires to each plate. He mounts a tongued contact-maker or breaker always in connection with one plate on a spindle of irregular shape, adapted to fit a key possessed only by those in charge of the plant, so that careless, mischievous, or insane persons (such as in an asylum) cannot tamper therewith. He covers this spindle by a guard plate with a hole to insert the key, and to prevent possibility of shock, he insulates the key part of the spindle from the contact-breaker in any suitable manner. To ensure the contact-maker or breaker being always "on" or "off," he mounts on it a cam or eccentric (which may carry a small friction roller if desired); this bears against a plunger set up by a spiral spring carried in fittings on the base. 4 claims.

9284. "Improvements in metallic telephone circuits." H. L. BURBANK. Dated June 4. 8d. Consists in certain arrangements of the circuits with respect to the several appliances at the several stations, whereby when all the stations are at rest the several call bell helices and call bell generators are serially connected in circuit, so that each station may receive a call from, or send a call to, the central station or exchange calls with each other, and whereby the calling circuit of both is opened when either station is using the line for conversation. 3 claims.

10801. "Improvements in electric lamps." H. PIEPER fils. Dated July 4. 8d. Claims:—1. In an electric lamp, the combination of a carbon rod, an electric circuit, two or more electrodes in contact with one end surface of said rod, one or more of the said electrodes being movable with its, or their, contact point or points lengthwise to the rod and means for pressing the movable electrode or electrodes against the end surface of the same, substantially as described. 2. In an electric lamp, the combination of a carbon-rod, an electric circuit, and two or more electrodes in

contact with one end of the said rod, one or more of the said electrodes being tubular and inclined upward from their points of contact with the carbon, substantially as specified. 3. In an electric lamp, the combination of a carbon rod, an electric circuit, two or more electrodes in contact with one end of the said rod, one or more of the said electrodes being movable, means for pressing the movable electrode or electrodes against the carbon rod, contact surfaces on the movable electrode or electrodes, other contact surfaces arranged opposite thereto, and each of which is conductively connected to the pole of the lamp, being of different denomination from that to which the corresponding movable electrode is connected, substantially as set forth.

20260. "Improvements in electric semaphores for railways." F. STITZEL, C. WEINDEL, A. REUTLINGER, M. J. SCHWARTZ, J. H. EGELHOFF, and J. KREIGER, Sen. Dated December 17. 8d. The object of the invention is to provide an electric semaphore apparatus which shall be simple in construction and effective in operation. A further object is to provide an electric semaphore apparatus which shall be sensitive and positive in operation, and require but a small amount of battery to operate it. A further object is to construct the device that its signal blade may be made to stop at each half revolution, to impart different information according to its position—said blade being entirely hid within a shield when in a vertical or "safety" position. A further object is to construct an electric semaphore in such a manner that a visual blade and night signal may be operated by the same mechanism. A further object is to provide an electrical semaphore apparatus with a rotary signal blade and a night signal, both of these signals being operated simultaneously by the same mechanism. 11 claims.

## CORRESPONDENCE.

### The Lineff System of Electric Traction.

I trust you will allow me brief space for replying to Mr. Lineff's courteous answer (in your last week's issue) to my recent remarks upon his system; not desiring to be esteemed by anybody as one of that sadly too numerous class who rush into places—especially into print—where angelic beings even are remarkably afraid to venture.

Since writing, a fortnight ago, I have had the advantage of being "personally conducted" over Mr. Lineff's system, so as to see all the ins and outs thereof; and, in the first place, as a result, I want to say that his new method is certainly a very great advance on the old. In my humble opinion, indeed, it ought to prove fully the best, in point of first cost and working expenses, of all the underground systems hitherto devised.

But one still cannot help feeling that Mr. Lineff has a little further to go before reaching perfection; and though suggestions from an outsider are perhaps ill-timed, yet the necessity for a more solid foundation as regards the magnetic rail sections, constantly is prompted to the mind.

I certainly believe that a continuous channel of cement set in the asphalt insulation would prove more serviceable than the tiles which Mr. Lineff proposes to employ.

The incessant jarring of wheels upon the numerous exposed rail-edges (which must result from the different coefficients of wear or compression in iron and asphalt) ought very soon to show how much the earthenware tiles—which support the magnetic rail sections—can stand in the way of blows.

It would be very interesting to watch the effect which the ordinary street traffic will produce upon the inch thickness of asphalt underneath the tiles.

If the bottom of a very thick layer of asphalt remains fairly elastic whilst a hard skin is formed by traffic on the exposed top, then it might be found that the iron and asphalt surfaces would settle down at pretty much the same rate.

With regard to the question of surface leakage, it appears almost as though the report did not say enough for the line, for the test which resulted in the lowest figure for insulation was decidedly abnormal.

The difference between the highest and the lowest is so great that anyone might well be excused for thinking there was a "nigger" in it.

Thus measurements taken at various times might

show resistances of 4,000, 3,000, 3,500, 3,700, 3,200, 2,750, and so on, with, perhaps, one abnormal record of 600. In a case like this, one would say that the average re-

sistance is certainly not  $\frac{4,000 + 600}{2}$ , but considerably

higher. The fault lies in not taking a sufficient number of instances.

I still, however, think that a wise man will only reckon with certainty upon his lowest figure, even though it be somewhat abnormal. Twenty per cent. dividends from a company that is only supposed to pay five are pocketed with far more cheerfulness than 25 per cent. from one that ought to give 30.

Another point to be mentioned is the diminished size of motor required for the Lineff car as compared with accumulator cars. But Mr. Lineff knows quite well that the output of motors increases in much greater proportion than the lineal dimensions and mass, or weight, either; and a very little extra weight in the motor is enough to give the increased power required by reason of the accumulator dead-weight.

As for the weight of the car itself, the present car frames are amply strong enough to carry the accumulators, and nothing need be added for that purpose.

I am sorry the illustrations of this system, published before my last letter, escaped my notice. I usually devour most of the technical journals, more or less dyspeptically, but lack of time must have caused me to overlook this item. It makes no difference, however, as Mr. Kapp's report contained a very good verbal description of the line.

I am glad to hear that the Lineff system is shortly to be tried on a larger scale in practical work along the West Metropolitan Company's line (subject to the permission of that august body, the Hammersmith vestry), and I sincerely wish Mr. Lineff every possible success. Every electrical engineer is anxious enough to see electric traction introduced all over this country, and, personally, I do not wish in any way to act as a brake upon invention. I only hope to be convinced that the Lineff system will, for some time to come, be able to show publicly the great benefits of electric traction, so that later on the converted Englishman will calmly submit to overhead tramway conductors, or anything else that is reasonable.

Frank B. Lea.

August 12th, 1890.

### Fall of Potential.

I have an engineering pocket book which gives me the loss of potential in 100 yards of, say, a strand of 7/16s, with a current of 10 ampères, which is used at the distant end. The loss of potential is given as 2.21 volts on the basis of the 1,000 ampères per square inch section of conductor. Now, I understand how to arrive at the loss of potential, if I either increase or decrease the length of my cable, keeping the current constant; but, suppose I want to pass 15 ampères through a length of 75 yards, what is then the fall, length and current both being altered?

Works Manager.

[The fall of potential along any wire is simply the current passing multiplied by the resistance between the two ends of the wire. In the example you give you have taken the fall of potential over *half* the circuit only instead of over the whole length, viz., 200 yards. If the wire has a resistance of .11 ohm per 100 yards, then the resistance of the total circuit (200 yards) will be .22 ohm, and as the current is 10 ampères, the fall of potential will be  $.22 \times 10 = 2.2$  volts. For a total length of 75 yards, i.e., a loop of 37.5 yards, the resistance will be  $\frac{75 \times .11}{100} = .085$  ohm, and if the current be 15 ampères the fall of potential will be  $.085 \times 15 = 1.275$  volts. For a loop of 75 yards, i.e., a total length of 150 yards, the fall of potential from end to end would of course be double, i.e., 2.55 volts.—EDS. ELEC. REV.]

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### M. GRAMME.

IN the report presented by the Comité des Arts Economiques to the Société d'Encouragement pour l'Industrie Nationale, in which M. Gramme's title to be awarded the Grande Medaille d'Ampère is set forth, M. Mascart reminds the committee that it is to Pixii, under Ampère's guidance, that we owe the first machine which has enabled us to dispense with chemical combinations in obtaining electrical currents. Thereafter the chief difficulty was to manipulate the natural alternation of these currents, so as to give them a like direction in the exterior circuit. Except in certain particular applications, arc lighting, for instance, where the inverse direction of the currents presented no inconvenience, the difficulty appeared to be insuperable. We can understand, therefore, the revolution that took place when, in 1869, M. Gramme invented his machine. It may be said that, for Paccinotti, the discovery existed in principle already, but, if so, this must have been unknown not merely to Gramme, but also to the scientific world, or how account for the astonishment which Gramme's discovery evoked? It must be borne in mind also that the feeling among competent persons was not altogether of a nature to encourage a comparatively unknown inventor, for it must be remembered that Gramme, who was then a simple workman, had but lately arrived in Paris, knowing merely how to read, write, and cipher, in addition to having some ideas of design picked up at odd moments. The best judges proved shortsighted in this case—even Breguet, who had received the inventor with his customary kindness, and defrayed the cost of patenting the invention, could hold out no hopes as to the future of the invention. Ten years later, at the International Exhibition of 1881, there was not a machine of old or new-world construction that had not its Gramme ring, and it is due to M. Gramme that Frenchmen are able to boast that the first alternating current machine and the first continuous

current machine were both constructed in France. It is these immense services rendered to the industry in general, and particularly in France, that the society desires to honour, and to this effect it has been decided to award to M. Gramme a special medal bearing the effigy of Ampère, thus at the same time rendering homage to the immortal creator of electro-dynamics.

### M. FERDINAND CARRÉ.

GENERAL SEBERT, in presenting the report of the Comité des Arts Economiques to the Société d'Encouragement pour l'Industrie Nationale, in which M. Ferdinand Carré's claims to the Henry Giffard prize of 6,000 francs for the most signal services rendered to French industry are set forth, observed that M. Carré's investigations in the artificial production of cold, and the manufacture of carbons for use in electric lighting, had had considerable influence on the industrial world. It was owing to M. Carré's investigations under the latter head that certain recent developments in electric lighting had been possible. The manufacture of carbons for electric lighting was at first by means of Foucault's method of pointing the carbons, a method capable only of producing an irregular and expensive article. That was in 1868. It was then that M. Carré, in a note addressed to the Academie des Sciences, pointed out a process by which some of the drawbacks of the Foucault process could be avoided. In 1876 he patented his draw-plate method, to which he subsequently added improvements with a view to securing regularity and excellence. These improvements included the composition of a carbonaceous paste and the choice of an adhesive liquid as well as ingenious processes for the burning, drying, and the impregnating of carbons under heat, by means of vacuum and compression; and it is due to them that the use of Jablochkoff candles has been possible. The sale of drawn carbons

has been considerable from the outset. With a view to modify the tint of the arc and to get rid of the incandescent particles projecting from the superficial strata, M. Carré first devised a hollow carbon furnished with a core of different composition, next a process whereby the carbons were impregnated with various salts subsequently removed from the outer layers by solution, so that only the core remained impregnated. These improvements he patented in 1878 and 1886. He also succeeded in producing a carbon to give out a red light. The fluted carbon, which is largely used in England, and was the subject of a patent in 1886, we also owe to M. Carré. Unfortunately, owing to these inventions not having been patented abroad, they are used without let or hindrance in foreign countries, and the inventor's profits are consequently greatly curtailed. But the services of M. Carré are freely acknowledged; and, in awarding the Giffard prize to him, the society is acting in accordance with the popular verdict.

### HOIST WITH HIS OWN PETARD.

"A GOOD letter has laid the foundation of many a man's prosperity." If there is any truth in this maxim, then, a correspondent, whom we assume to be very youthful, and whose communication upon cable-testing appears in another column, commences life with a good augury for his future career.

We need not refer to the *raison d'être* of Mr. Hall's letter, for it explains itself. The characteristics of such compilations as his should be conciseness and perspicuity, and on these points the gentleman, whose wrath we have incurred, is strong indeed; with the exception of a few terms of compliment, not a superfluous word should be admitted, and in this respect our correspondent is rigorously exact; indeed, the composition may be characterised as one of those efforts of polite letter-writing, in which all words not absolutely indispensable are omitted, giving rise to a forcible style, in which will be found all the essentials of true elegance.

While regretting that we do not number Mr. H. Cuthbert Hall amongst our regular readers, we can still congratulate our contemporary, whose devotion to submarine cable interests is supposed to be the sole object of its existence, upon having secured a contributor of such originality in research, and upon whose broad shoulders the mantle of Faraday is evidently destined to fall.

In reality, the matter at issue is so simple, old, and utterly unimportant, that we should not have entered into any discussion except out of sheer good nature to Mr. Hall, whose error in this respect, might, on some future occasion, lead him into one still greater if his vapourings were not checked with a firm hand and good intent withal. Why our correspondent should characterise the simple statement that his device is old, as unscientific criticism, is best known to himself. Moreover, that assertion is not argument, nor inaccurate

statement, proof, are truisms not unknown to us, but in how much our remarks justify Mr. Hall's reminder can best be seen by the appendices to his letter.

Probably after a perusal of these, Mr. Hall will regret having sent us a communication which can scarcely be said to comply with the precept,

"Adopt with every man the style and tone  
Most courteous, most congenial with his own."

unless, indeed, he is utterly devoid of sentiment of this nature.

It remains now to be seen whether, after our acceptance of the challenge thrown out by him, and the complete vindication of our statement that the method of cable testing he described is neither novel nor interesting, he will have the manliness to apologise for his hasty and ill-advised epistle.

### THE PETROLEUM ENGINE COMPANY, LIMITED.

THE company formed in 1888, for the development of the petroleum engine industry, by the manufacture of engines under the patents of Etéve, Hume and Priestman, for the United Kingdom and the British Colonies, including Canada and India, has just issued its annual report. It appears that the royalties received show a steady progression from £18 in 1888, to £559 and £1,035 in 1889 and 1890 respectively, and out of these amounts the directors' fees (£400) and other expenses of management, together £605 *per annum*, have to be deducted. At this rate, another three or four years will probably be passed before a modest 5 per cent. can be received by the shareholders, and it seems a convenient opportunity to now consider whether some changes cannot be made which shall tend to the return of the capital expended as the lives of the patents expire, and also to a reasonable interest on it during that period.

The utility of the engines has been amply demonstrated for many purposes, such as electric lighting, chaff cutting and threshing, driving lathes and tools, pumping, driving dairy and bread making machines, &c. In regard to the use in conjunction with dynamo machines, we have always had a high opinion of the engine's merits, and as the company possesses many first-class testimonials from practical and well known users, the difficulties incidental to the introduction of a new engine should by this time have disappeared.

The fees of the directors, £100 each, we think should be voluntarily reduced, seeing that the management is of an almost nominal character, Messrs. Priestman Bros. having not only the manufacture but the sale of the engines also, mainly in their hands.

It would be very interesting to know how much Messrs. Ernest Scott and Co., the second firm licenced, have done, what amount of royalties has accrued from their manufacture, and if but little (for we see no mention of their name in this year's report), why it is so. Have they had all facilities for making engines of the latest patterns, and if not, why not?

It seems likewise desirable that the petroleum engines should be well pushed in the colonies and India; are they being introduced there with all the energy and tact that can be brought to bear upon the business?

The directors have a really good thing to manage, and if those who now manufacture cannot go ahead faster, surely others can be found to undertake the work, so that the shareholders may soon have an opportunity of getting for their outlay at least some interest thereon.

#### Localising Faults in Insulated Wires.

AT Silvertown, the insulated trough method of localizing faults is no longer in use. It was found that when the core was covered with any fibrous material, the passing of it through a trough of water was too slow a process, as, unless the fault was a very decided one, it was necessary to proceed slowly, to allow the covering to get soaked. Mr. Hawkins has used a method which is as follows:—The core to be examined has one end sealed; beginning with this end it was wound on a drum which revolved in a trough of water, the latter being to earth. The other drum from which the core was being unwound had a hole through the side, through which the end of the core protruded, and was fastened by a screw to a brass or copper disc carried by an ebonite collar fitting on to the drum spindle. Contact was made by a spring which pressed against the periphery of the revolving disc, the other end of the spring having a lead to battery and galvanometer. Mr. Hawkins found that the drum upon which the cable was wound being in water, there was no fear of having the fibre insufficiently soaked. At Siemens's works the method devised by their electrician, Mr. F. Jacob, and described in Kempe's Handbook, has been in use some 15 years. The whole point of the method lies in having the external coating of every portion to earth, except that which is connected through the galvanometer to earth; thus the resistance along the outside of the wet core being considerably higher than the resistance of the galvanometer, any current through the fault in the portion connected to the galvanometer goes mostly through that instrument, whereas if the other portion is only on insulated drums, and the outside of the core is not perfectly insulated between that and the portion connected to the galvanometer, any small fault is most difficult to localise.

#### The P. M. G.'s Progress.

MR. RAIKES has caused questions to be asked by circular letter of those having registered telegraph addresses: 1st, as to whether the addressee has any objection to the publication of his registered address. 2nd, as to whether, if a list were published (of addresses in London), the addressee would wish to have a copy, the fee for registration, together with a quarterly copy of the list, being two guineas a-year. The idea of issuing a list seems to be a very good one, but to be thoroughly useful it should be extended to the whole of Great Britain—i.e., all telegraph addresses in the United Kingdom should be brought into one list. This list, we think, need only be issued annually, and in that case it might be found possible to bring it out for the extra guinea to be charged beyond the usual guinea for

the registration. For a list of London addresses only we consider a guinea by far too high a price. We do not know what number of registered addresses there may be in the whole of Great Britain, but this may be said safely that the greater the number the larger would be the demand for the list, and consequently the cheaper should be the relative cost of its production.

#### The Need for a Pacific Cable.

THE Melbourne *Evening Standard* of July 14th, 1890, has a somewhat lengthy article on the subject of the Pacific cable, and, having pointed out the various disadvantages of other routes, says:—"Against these many disadvantages the Pacific route offers a security in that throughout its entire length—across Canada from Vancouver to Hawaii, Fanning Island, Samoa and New Zealand—it would only touch foreign territory at Honolulu and Tutuila, while, as experience has abundantly proved, the greater depth at which the cable would lie would render it less liable to injury through volcanic disturbance, besides giving it greater protection against any hostile attempt at severance. In recognition of the advantages which the enterprise of the Eastern Extension Company has secured to Australia, Sir John Pender should be dealt with in a fair and liberal spirit. But it should not be forgotten that the benefit has been mutual, and that the Australian share would be terribly discounted if, by losing interest in the Pacific cable, it were to sacrifice its safety." We are glad to see the Melbourne Press fully alive to the true interests of the Colonies in the above matter, and sincerely trust that through such means the public opinion of Canada, Australia and New Zealand may be guided to the successful carrying out of this absolutely necessary enterprise.

#### Telegraph Poles for Advertising Purposes.

A MELBOURNE (Australia) paper says "there is every reason to believe that an arrangement will be entered into whereby the present unsightly wooden poles which support the street telegraph wires will be transformed into advertising hoardings, with due regard to the æsthetic cravings of the pedestrians. It is claimed that no damage will be done to the property of the Post Office, and that while the City Council will take proper precautions to prevent the impeding of traffic, the advertising company will substitute symphonies in gold, pink, and azure for the black tar besmirched posts, whose ugliness is but hardly excused even on utilitarian grounds." On reading the first few lines we were struck with horror to think what such a similar arrangement might do for our English towns, for although it is conceivable that harmonious designs by Burne Jones, Edward Poynter, Walter Crane, Whistler and others might prove interesting, nay, even instructive to art lovers among the public, yet we fear that in but too many cases colour and form would be sacrificed to giving prominence to the commercial aspects of the announcements. Telegraph poles, at any time, appear as defects in a landscape, but transformed into "advertisement hoardings" they would be simply atrocious, unbearable. Happily, however, there is not much fear that our Postal Department would be a party to such an arrangement as that indicated above, even though impertuned to be so.

FRANKLAND'S RESEARCHES ON THE  
CHEMISTRY OF STORAGE BATTERIES.

THE chemical changes which take place during the charging and discharging of storage batteries have been the subject of considerable difference of opinion amongst chemists and physicists. Some authorities have maintained that the effects are dependent on the occlusion of oxygen and hydrogen gases on the plates, whilst others, regarding the question from another point of view, have held that lead sulphate plays an important part in the phenomena. That the differences of opinion amongst experts have been widely divergent may be recognised from the fact that scientists, who, apparently, are well competent to express their views, have asserted that no chemical change of the lead sulphate occurs either in the charging or discharging of the plates.

In order to test the accuracy of the former opinion, Dr. Frankland, some time ago, undertook a series of experiments, the results of which were communicated to the Royal Society (*vide* Proceedings Royal Society, XXXV., p. 67). Two plates of lead were twisted into a corkscrew form, the gutter of the screw being filled with red lead; these plates were immersed in dilute sulphuric acid and charged in the usual way. When these plates were subsequently heated and the gas evolved, collected and examined, it was found that mere traces of oxygen and hydrogen were expelled, whereas, if the theory had been correct, there should have been a copious evolution. Hence, it was concluded, that the important agent in the cell is not constituted by the occluded gases.

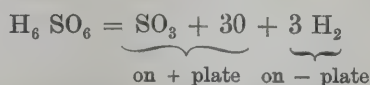
With regard to the lead sulphate, Dr. Frankland observed that in charging a strong cell, a considerable amount of sulphuric acid disappears, and is accompanied by a certain deposition of lead sulphate, but that the deposit formed is inadequate to account for the total acid which has disappeared.

The strength of the acid ceases to diminish and afterwards increases as the charging of the cell proceeds; this change continues until the maximum charge has been reached, and oxygen and hydrogen gases are evolved from the positive and negative plates respectively.

When the cell is discharged, the phenomena above described are reversed, the specific gravity of the acid decreasing from the point from which it began to increase on the charging of the cell.

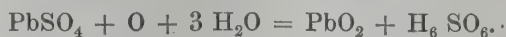
From these experiments and the observations made upon them, Dr. Frankland deduced the following results, representing the changes which occur in charging a storage battery, viz.:

1. The electrolysis of hexabasic sulphuric acid (*i.e.*,  $H_6SO_6$ ) according to the equation



2. The reconversion of the evolved sulphuric anhydride ( $SO_3$ ) into the corresponding acid ( $H_2SO_4$ ).

3. Chemical action on the coating of the positive plate according to the equation



4. Chemical action on the coating of the negative plate according to the equation



When the storage battery is *discharged*, the first two changes observed in charging the battery are repeated. Further, on the coating of the positive, formerly the negative electrode, the chemical change which takes place is represented by the equation



on the coating of the negative. Finally, the positive electrode, the change occurring is represented by the equation



Hence Dr. Frankland formed the opinion that the formation of the cell consists in the more or less thorough decomposition of those portions of the lead sulphate comparatively removed from the conducting metallic nucleus of the lead. Lead sulphate possesses a low specific conducting power, whilst lead peroxide, and especially spongy lead, offer comparatively little resistance to the current, which is thus enabled to bring the outlying portions of the coating under its influence.

Since these results were published, Dr. Frankland has been pursuing his researches in the same direction. He undertook a series of experiments with a view to ascertaining what lead compounds actually take part in the chemical reaction in charging and then discharging secondary batteries.

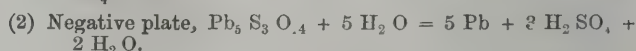
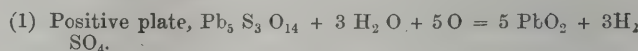
A quantity of lead oxide ( $PbO_2$ ) reduced to a fine powder was treated successively with portions of dilute sulphuric acid until the liquid became permanently acid. On being allowed to stand, a buff-coloured precipitate separated from the mixture and was found by analysis to possess the formula  $Pb_5S_3O_{14}$ .

When finely powdered lead ( $Pb_3O_4$ ) was treated in the same way with dilute sulphuric acid, the powder which settled on standing was brownish-red in colour, and was found on analysis to have the constitution  $Pb_3S_2O_{10}$ .

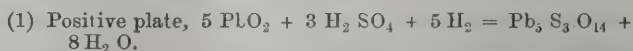
Dr. Frankland considers that these hitherto unknown or undescribed salts constitute the original active material of storage cells, and that the following equations accurately represent the reactions which take place on the surface of the plates on charging and discharging the battery.

A. If the buff-coloured salt is the active material used, then

I. on charging—

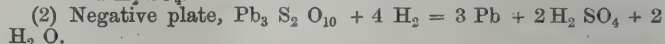
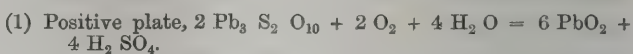


II. on discharging—

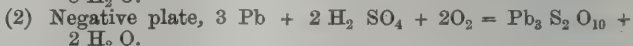
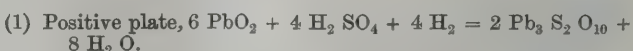


B. If the brownish-red coloured salt is the active material used, then

I. on charging—



II. on discharging—



It is worthy of remark that in practice, only half as much material seems to be necessary for the negative as for the positive plates, and this is evidence in favour of the latter alternative, B, being correct.

We cannot assume, however, that there is nothing more to be discovered concerning the chemical action of storage batteries. The subject is full of complications, and it is to be hoped that electricians will receive further and large assistance from chemists who alone, perhaps, are able to throw the necessary light upon these obscure matters.

## EDINBURGH EXHIBITION.

(Continued from page 126.)

*The Barothermotelemeter.*—With Mr. Johnston Stephen, of Edinburgh, the Lord Justice Clerk is joint inventor of this instrument. It is for the purpose of enabling observers to take readings as often as desired, and by a single wire, from barometers and

thermometers placed at great heights or distances, without the necessity of the observer being resident where the instruments are placed, thereby saving much expense, and enabling observations to be taken at points where residence might be impossible. The barometer has inserted in its mercury a rod of insulating material, on which a screw thread has been cut, and on this thread a fine wire is wound. An electric circuit, established through this coiled wire to the mercury, and by a conductor from the mercury to earth, will, of course, meet with more or less resistance, according to the height of the barometer, as the coils are more or less short-circuited by the mercury. The thermometer has two carbon threads passed down into the mercury, and in the same way as in the case of the barometer the resistance is increased or reduced by the fall or rise of the mercury lengthening or shortening the circuit through the carbon threads. The procedure by the observer at a receiving station consists in taking, first, a reading of the line resistance, without passing the current through the instruments, then passing the current through the instruments in succession, and taking readings, correcting these by the reading of the line wire. The mode in which these changes are

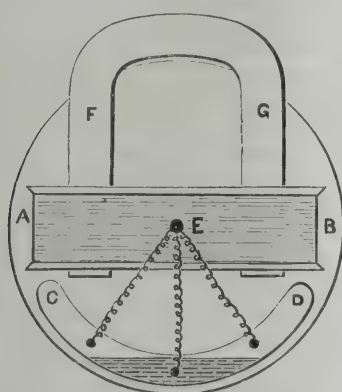


FIG. 1.

accomplished is shown in fig. 1. The flat coil, A, B, is balanced on the pivot, E, and the permanent fixed magnet, F, G, rests within the coil. On the circular disc, to which A, B is attached, a curved tube, C, D, is placed, which has a metal plate along its lower side, and a small quantity of mercury (shown by the shading).

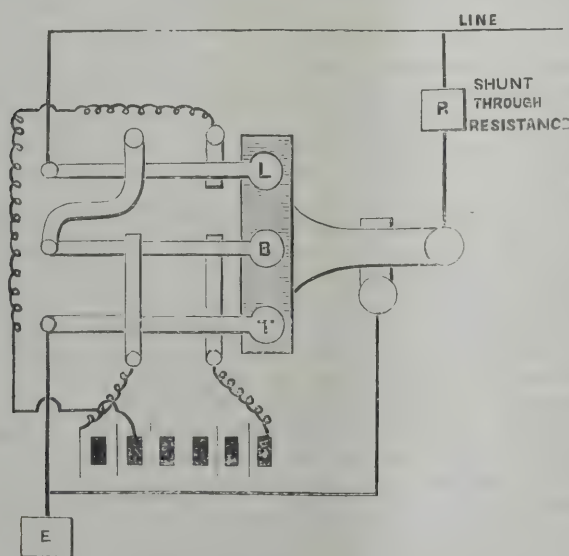


FIG. 2.

Three wires are inserted in the upper side of the tube—one in the centre, and one near each end. When the tube, C, D, is at rest a weak current passed from the line through the centre wire will not disturb the position of C, D. The line resistance can thus be noted.

If a strong + current be then passed, C, D is moved so that the mercury leaves the centre wire and makes contact with one of the side wires, and thus shunts the circuit from the line through the barometer circuit, the resistance of which is then checked. The thermometer is then checked by passing a strong - current, which turns C, D in the opposite direction, and makes the circuit through the other side wire. The mode in which these switchings are accomplished at the observing station is shown in fig. 2. It will be seen that when the key, L, is used a weak current passes to line, when the key, B, is used a strong + current passes, and when the key, T, is used a strong - current passes. In each case, when the key is still further depressed, it gives the current an alternative path through a bridge and proportional coils, thus enabling the readings of the resistance to be taken. The upper side of the large key, which connects the rheostat, is covered with insulating material to prevent short-circuiting.

### A NEW FORM OF GAS BATTERY.

AT one of the meetings of the Royal Society, a short time ago, a new form of gas battery was described by Messrs. Ludwig Mond & C. Langer. There are several forms of gas battery already known, but the peculiarity of this latest modification is that it is a *dry* gas battery.

The new battery may be thus briefly described:—A diaphragm of some porous non-conducting material, such, for example, as plaster of Paris, is saturated with dilute sulphuric acid, or with some other common and suitable electrolyte. This diaphragm is covered on both sides with thin platinum foil, which has been finely punctured, and which contains about 1,500 perforations per square centimetre. The foil is overlaid in its turn by a thin film of platinum black.

The internal resistance is reduced to a minimum by placing the foil in contact at short intervals with strips of some good conductor.

A number of such diaphragms having been prepared in the manner described, they are placed side by side, or one above the other, with non-conducting frames intervening; this arrangement forms chambers through which the gases employed are passed. One side of each diaphragm is exposed to the action of air or hydrogen, whilst the alternate sides are exposed to the action of hydrogen gas, and the spaces which exist between the diaphragm are so connected that the gases pass through the whole series each in its own proper way.

Experiments were made in order to estimate the electromotive force of such a battery as this, with the result that it (the E.M.F.) was found to vary considerably with the quality of the platinum black.

The best result obtained was:

$$\text{E.M.F.} = 0.97 \text{ volt,}$$

and this was yielded when platinum black, prepared as follows, was employed, namely, by precipitation from a boiling solution of platinum tetrachloride by neutralising with sodium carbonate, and afterwards reducing with a boiling solution of sodium formate.

The resistance of a plate of plaster of Paris, 8 mm. in thickness and having 350 sq. cm. of surface, was found to be

$$R = 0.02 \text{ ohm.}$$

The maximum amount of work was obtained from this battery when the external resistance was nearly double the value of the internal resistance.

After much experiment it was found most convenient to work the battery with an electromotive force of about 0.73 volt, which allows a current of from 2.0 to 2.5 amperes to be taken out of an element with 700 sq. cm. of active surface covered with 0.35 gramme of platinum foil and 1 gramme of platinum black. The temperature should be maintained constant at 40° C. by passing excess of air through the battery.

About one-half of the energy of combustion of the

hydrogen gas is converted into electrical energy; this is, comparatively speaking, a high value.

Messrs. Mond and Langer, besides experimenting with oxygen and hydrogen, also tried air and a gas containing from 30 to 40 per cent. of hydrogen—a gas, in fact, such as can be got by the action of steam, with or without air, on coal or coke.

As might be predicted, this battery after having been at work for some time begins to exhibit signs of polarisation. In the opinion of Messrs. Mond and Langer, this phenomenon is caused by a charge in the concentration of the acid at the two electrodes, and may be remedied by interchanging the gases from time to time; this can be effected with the greatest ease since the materials to be interchanged are gaseous.

It is only fair to remark, in conclusion, that Messrs. C. R. A. Wright and C. Thompson have recently stated that the gas battery described by Messrs. Mond and Langer is practically identical in principle with one described by them in 1888 in a paper entitled "On the Development of Voltaic Electricity by Atmospheric Oxidation" (*vide Proceedings Royal Society*, Vol. XLIV., p. 182), and which was perhaps foreshadowed in a previous paper by them, entitled "Note on the Development of Voltaic Electricity by Atmospheric Oxidation" (*vide Proceedings Royal Society*, Vol. XLII., p. 212.)

## A SYNTHETIC STUDY OF DYNAMO MACHINES.

(Continued from page 40.)

### IX.—THE HEATING OF MACHINES.

IN every dynamo there is performed internally while running a certain amount of work, first, in forcing the current through conductors having some resistance; secondly, in continually changing the direction of the magnetism in the armature core; thirdly, in generating in the latter feeble parasitic currents. The energy thus dissipated appears in the form of heat; accordingly the machine increases in temperature from the time it is started, and attaining a maximum when the rate of losing heat into the surrounding air is exactly equal to the rate at which it is generated in the machine. There is also, in addition to the above, some work done in overcoming the friction of the journals. As this need be no greater than in other machinery through which at the same speed similar power is transmitted, the heating arising therefrom calls for no special attention.

In fixing the heating limits, two things must be borne in mind. First, the temperature must not be great enough to cause deterioration of the insulating material; secondly, the variation must not be great enough to give trouble from the expansion and contraction of the metal parts. As regards the armature, there is some difficulty in measuring the actual temperature of the conductors. As a rule, they are covered all round with insulating material, and the usual way being to lay the thermometer on the insulation when the machine stops running, what is actually observed is, of course, the temperature attained by the outside covering. On the other hand, what we actually take the indication from is of little importance, provided the observation affords a guide as to whether the temperature of any part gets too great. It is certain that the wires next the core, in an armature wound with, say, four layers of .048 inch diameter wire, would be a good deal hotter than would be indicated immediately by a thermometer placed on the covering of the outer wires when the machine stops. At the same time if we know from experience, that the heating of the inside wires is harmless when the temperature of the outside covering does not with the thermometer left on exceed a certain amount, an observation of the outside temperature should furnish us with a perfectly

reliable guide as to what cooling surface should be allowed. In practice we can only measure the surface temperature, and, given a certain rate of generating heat, the temperature which the surface attains in running depends upon its extent and character, and on the speed of rotation. But the difference of temperature between the interior and the outside depends upon the thermal resistance encountered by the heat in flowing to the surface. In an armature wound with one layer of coarse wire, for example, it would require less difference of temperature to produce a given flow of heat than in one wound with several layers of fine wire. In the former there is only one layer of cotton insulation for the heat generated in the copper to flow through, while in the latter the flow to the surface takes place partly by conduction round and round the fine wire and partly through the several layers of badly conducting cotton covering. But by leaving the thermometer on the machine, and noting the maximum to which it rises, we can readily obtain an idea of the temperature to which the underneath insulation is subjected.

The interior of the core is always hotter than the underneath layers of wire, even if the heat generated in the iron itself is small. When the armature is built of plates the difference in temperature between the interior and exterior of the core is little, as the iron forms a continuous conductor which carries off the heat fairly well; but if constructed of iron wire the difference is greater, as the flow of heat is obstructed by badly-conducting substances (cotton covering, varnish, &c.). When a machine is started the heat flows from the copper into the surrounding air also into the iron core, the latter being for a time the cooler. As the run continues the core increases in temperature from this reception of heat, also on account of a certain amount being generated in its own mass. Its temperature becomes in time equal to that of the adjacent conductor, when it neither receives nor loses heat. Finally, it rises above that of the conductor by an amount just sufficient to cause its heat to flow outwards through intervening substances.

It will be seen, then, that the maximum temperature may not be attained for a considerable time, as, due to the absorption of heat by the core, the cooling surface is virtually large to start with, but gets less and less as the core attains its maximum. When the ultimate temperature is reached, the heat is radiated from the exterior surface only, and the heat thus radiated is exactly equal to the heat generated. The time it takes for the machine to reach its ultimate temperature varies considerably, as might be expected. Very often the maximum temperature is not attained in large machines until they have run for six or eight hours, while in smaller machines a two to three hours' run may be sufficient. For a thorough test, the machine should be run with full load until its temperature ceases to rise.

Some difference of opinion exists with reference to the temperature which should be permitted. The British Admiralty allow a rise of about 40° C. above the surrounding atmosphere, and engineers are generally specifying this limit for the contracts of which they have charge. The measurement is taken by placing the thermometer on the armature after the machine has stopped, and noting the maximum attained. It thus indicates something less than the actual temperature of the core and conductors, but affords a reliable enough indication as to whether the heating in these is too great. If the rise measured in this way does not exceed 40° C., the insulating material is considered to be in no danger of deterioration.

Remembering that the Admiralty dynamos have often to work in an atmosphere of some 50° C., this rise seems somewhat ample, while for land dynamos, working under ordinary conditions, it does very well. Mr. Esson, in his recent paper, stated as his opinion that in no case should the maximum temperature exceed 75° C. i.e., the temperature of the room added to the rise in continuous running. In the continuous running of an

Edison-Hopkinson dynamo for three weeks at full load the temperature of the armature varied from 76° C. to 84° C., keeping throughout the run about 60° above the surrounding air. In America they work much hotter, and accordingly we find the United Edison Manufacturing Company specifying that after a 10 hours' run at full load no conductor or other electric part of their dynamos shall have a temperature of more than 80° C. above the surrounding atmosphere. This, to British electricians, seems excessive, though the reflection that the American limit is not exceeded may, at times, comfort them, when, for some unforeseen reason, a machine runs hotter than usual. Speaking generally, a temperature limit of 75° C., which includes a rise of from 30° to 40° C., is not exceeded by the best English practice.

(To be continued.)

### TESLA'S NEW ALTERNATING MOTORS.\*

FOR some time past Mr. Nikola Tesla, whose previous work in alternating current motors is well known, has been engaged upon the study of these machines, in order to develop efficient methods for operating them on two wires instead of three, and still without the use of a commutator.

The general principle upon which these machines are designed is based on the well-known fact that if a magnetic core, even if laminated, be wound with a coil, and a current be sent through, the magnetisation of the entire core does not immediately ensue, the magnetising effect not being exhibited in all parts simultaneously. This Mr. Tesla attributes to the fact that the action of the current is to energise first those laminæ or parts of the core nearest the surface and adjacent to the exciting coil, and from thence the action progresses towards the interior. A certain interval of time, therefore, elapses between the manifestation of magnetism in the external and the internal sections or layers of the core.

If the core be thin or of small mass, this effect may be inappreciable, but in the case of a thick core, or even of a comparatively thin one, if the number of alternation be very great, the time interval occurring between the manifestations of magnetism in the interior of the core and in those parts adjacent to the coil is more marked, and in the construction of such apparatus as motors which are designed to be run by alternating currents, Mr. Tesla has found it desirable, and even necessary, to give due consideration to this phenomenon and to make special provisions in order to obviate its consequences.

On the other hand, by taking advantage of this very action or effect, and, by rendering it more pronounced, Mr. Tesla utilises it in the operation of motors in general. This he effects by constructing a field in which the parts of the core that exhibit at different intervals of time the magnetic effect imparted to them by alternating currents in an energising coil are so placed with relation to a rotating armature as to exert thereon their attractive effect successively in the order of their magnetisation. By this means there is secured a result similar to that which Mr. Tesla has heretofore attained in the previous types of his motor, in which, by means of one or more alternating currents, he produces a rotation or progression of the magnetic poles or points of maximum attraction of the field of force.

The general principle involved in the action above mentioned is illustrated in the simple motor shown in fig. 1. Here X represents a large iron core composed of a number of sheets or laminæ of soft iron or steel. Surrounding this core is a coil, Y, which is connected with a source, E, of rapidly varying currents.

Let us consider now the magnetic conditions existing in this core at any point, as *b*, at or near the centre, and any other point, as *a*, nearer the surface. According to Mr. Tesla, when a current impulse is started in the magnetising coil, Y, the section, at *a*, being close to the coil, is immediately energised, while the section, at *b*,

which, to use a convenient expression, is "protected" by the intervening sections or layers between *a* and *b*, does not at once exhibit its magnetism. However, as the magnetisation of *a* increases, *b* becomes also affected, reaching finally its maximum strength some time later than *a*. Upon the weakening of the current the magnetisation of *a* first diminishes, while *b* still exhibits its maximum strength, but the continued weakening of *a* is attended by a subsequent weakening of *b*. Assuming the current to be an alternating one, *a* will now be reversed, while *b* still continues of the polarity first imparted. This action continues, the magnetic condition of *b* following that of *a* in the manner above described.

If an armature, for instance, a simple disc mounted to rotate freely on an axis, be brought into proximity to the core, a movement of rotation will be imparted to the disc, the direction depending upon its position relatively to the core, the tendency being to turn the position of the disc nearest to the core from *a* to *b*, as indicated in fig. 1.

This action or principle of operation has been embodied in a practicable form of motor, which is illustrated in fig. 2. Here A represents a circular frame of iron, from diametrically opposite points of the interior of which the cores project.

Each core is composed of three main parts, B, B, and C, and they are similarly made with a straight portion, *e*, around which the energising coil is wound, a curved arm or extension, *c*, and an inwardly projecting pole, *d*.

Each core is made of two parts, B, B, with their polar extensions reaching in one direction and a part, C, between the other two and with its polar extension reaching in the opposite direction. These cores are wound with coils, D, which are connected in the same circuit either in parallel or series and supplied with an alternating current by a generator, E, represented diagrammatically. Between the cores or their polar extensions is mounted an armature, F, wound with magnetising coils, G, that are closed upon themselves, similar to those in the older types of Mr. Tesla's motors.

The operation of the motor is as follows:—When a current impulse or alternation is sent through the coils, D, the sections, B, B, of the cores being on the surface, and in close proximity to the coils, are immediately energised. The sections, C, on the other hand, are protected from the magnetising influence of the coil by the interposed layers of iron, B, B.

As the magnetism of B, B increases, however, the sections, C, are also energised, but they do not attain their maximum strength until a certain time subsequent to the exhibition by the sections, B, B, of their maximum.

Upon the weakening of the current, the magnetic strength of B, B first diminishes while the sections, C, have still their maximum strength; but as B, B continue to weaken, the interior sections are similarly weakened.

B, B may then begin to exhibit an opposite polarity, which is followed later by a similar change on C, and this action continues.

B, B and C may, therefore, be considered as separate field magnets, being extended so as to act on the armature in the most efficient positions, and the effect is similar to that in Mr. Tesla's other forms of motor, viz., a rotation or progression of the maximum points of the field of force. Any armature, such, for instance, as a disc mounted in this field, would rotate from the pole first, to exhibit its magnetism to that which exhibits it later.

In following out the ideas stated above, Mr. Tesla has applied them to a class of motors in which two or more sets of energising magnets are employed, and in which by artificial means a certain interval of time is made to elapse between the respective maximum or minimum periods of their magnetic attraction or effect. This has already been applied to the operation of Mr. Tesla's three-wire motors. In the present instance Mr. Tesla employs a motor with two sets of energising or field

\* *Electrical Engineer.*

magnets, each wound with coils connected with a source of alternating currents, but forming two separate paths or circuits. The magnets of one set are protected to a certain extent from the energising action of the current by means of a magnetic shield or screen of laminated iron interposed between the magnet and its energising coil.

The shield is properly adapted to the conditions of particular cases so as to shield or protect the main core

The engraving, fig. 4, shows the simplest form of this type of machine. The cores, B, form one set of magnets, and are energised by coils, D, while the cores, C, forming the other set, are energised by coils, E, and the coils are connected in series with one another, in two derived or branched circuits, F, G, respectively.

Each coil, E, it will be noted, is surrounded by a magnetic shield, H, which is composed of an annealed insulated or oxidised iron wire wound on the coils in

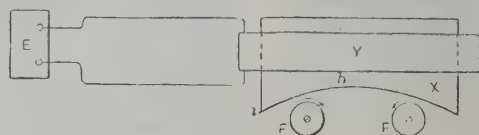


FIG. 1.—TESLA ALTERNATING MOTOR.

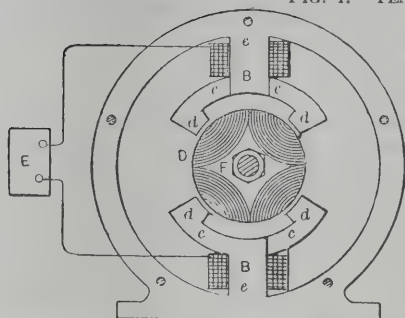


FIG. 2.—TESLA ALTERNATING MOTOR.

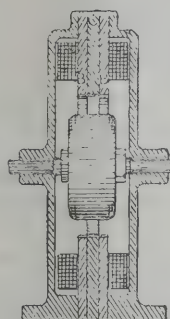


FIG. 3.—TESLA ALTERNATING MOTOR.

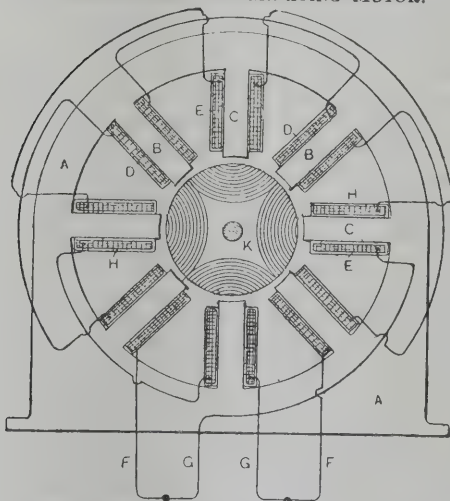


FIG. 4.—TESLA ALTERNATING MOTOR.

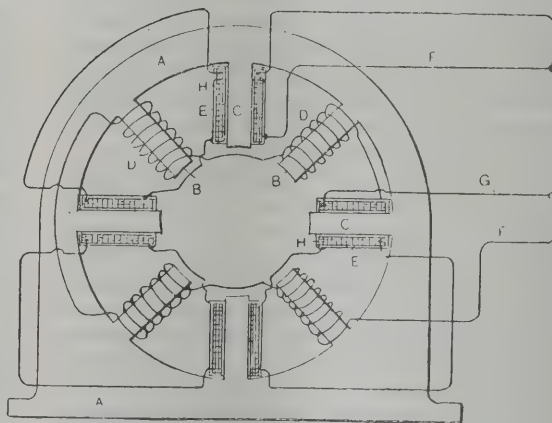
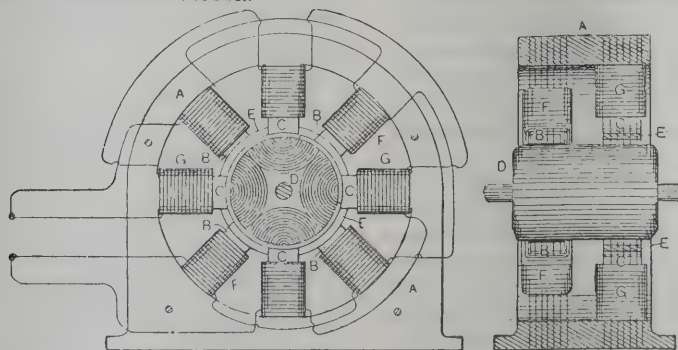


FIG. 5.—TESLA ALTERNATING MOTOR.



FIGS. 6 AND 7.—TESLA ALTERNATING MOTOR.

from magnetisation until it has become itself saturated, and no longer capable of containing all the lines of force produced by the current. By this means it will be seen that the energising action begins in the protected set of magnets, a certain arbitrarily determined period of time later than in the other, and that by this means a practically economical difference of magnetic phase may readily be secured.

The nature and operation of this motor will be readily understood by reference to the accompanying illustration.

the manner indicated, so as to form a closed magnetic circuit around the coils, and between the same and the magnetic cores, C. Between the pole pieces or cores, B, C, is mounted the armature of the closed circuit coil type.

The operation resulting from this arrangement is as follows:—If a current impulse be directed through the two circuits of the motor, it will quickly energise the cores, B, but not so the cores, C, for the reason that in passing through the coils, E, there is encountered the influence of the closed magnetic circuits formed by the

shields, H. The first effect is to effectively retard the current impulse in circuit, G, while at the same time the proportion of current which passes does not magnetise the cores, C, which are shielded or screened by the shields, H.

As the increasing electromotive force then urges more current through the coils, E, the iron wire, H, becomes magnetically saturated and incapable of carrying all the lines of force, and hence ceases to protect the cores, C, which become magnetised, developing their maximum effect after an interval of time subsequent to the similar manifestation of strength in the other set of magnets, the extent of which may be arbitrarily determined by the thickness of the shield, H, and other well-known conditions.

From the above it will be seen that the apparatus or device acts in two ways. First, by retarding the current, and second by retarding the magnetisation of one set of cores, from which its effectiveness will readily be seen.

Many modifications of the principle here embodied have been made by Mr. Tesla, one only more of which we may notice here. This is illustrated in fig. 5, and is similar in all respects to that above described, except that the iron wire, H, which is wrapped around the coils, E, is in this case connected in series with the coils, D. The iron wire coils are connected and wound so as to have little or no self-induction, and, being added to the resistance of the circuit, F, the action of the current in that circuit will be accelerated, while in the other circuit, G, it will be retarded.

Still another type of motor constructed by Mr. Tesla is one with a field magnet having two sets of poles or inwardly projecting cores, and placed side by side so as practically to form two fields of force, and alternately arranged, that is to say, with the poles of one set or field opposite the spaces between the other. The free ends of one set of poles are then connected by means of laminated iron bands or bridge pieces of considerably smaller cross-section than the cores themselves, so that the cores all form parts of complete magnetic circuits.

When the coils on each set of magnets are connected in multiple circuits from an alternating machine electromotive forces are set up in each circuit simultaneously, but the coils on the magnetically bridged or shunted cores will have, by reason of the closed magnetic circuits, a high self-induction which retards the current, permitting at the beginning of each impulse but little current to pass. On the other hand, no such opposition being encountered in the other set of coils, the current passes freely through them, magnetising the poles on which they are wound.

As soon, however, as the laminated bridges become saturated and incapable of carrying all the lines of force, which the rising electromotive force, and consequently increased current, produce, free poles are developed at the ends of the cores, which, acting in conjunction with the others, produce rotation of the armature.

The construction by which this is accomplished is shown in the accompanying engravings, figs. 6 and 7.

The frame of the motor, A, is built up of sheets of iron, punched out to the desired shape and bolted together with insulation between the sheets. When complete, the frame makes a field magnet with inwardly projecting pole-pieces, B and C. To adapt them to the requirements of this particular case, these pole-pieces are out of line with one another, those marked, B, surrounding one end of the armature, and the others, C, the opposite end, and they are arranged alternately; that is to say, the pole pieces of one are set in line with the spaces between those of the other sets.

The pole-pieces, C, are connected or shunted by bridge pieces, E.

The coils, F and G, are connected in series, respectively, in two circuits, which are branches of a circuit from an alternating machine, and they are so wound that the circuit of coils, G, will have a higher self-induction than the other circuit or branch.

The function of the shunts or bridges, E, is that they shall form with the cores, C, a closed magnetic circuit

for a current up to a predetermined strength, so that when saturated by such current, and unable to carry more lines of force than such a current produces, they will, to no further appreciable extent, interfere with the development by a stronger current of free magnetic poles at the ends of the cores, C.

In such a motor, the current is so retarded in the coils, G, and the manifestation of the free magnetism in the poles, C, is delayed beyond the periods of maximum magnetic effect in poles, B. The result is that a strong torque is produced, and the motor operates with approximately the power developed in a motor of this kind, energised by independently generated currents, differing by a full quarter phase.

## THE BREMEN ELECTRIC TRAMWAY.

As already announced in the REVIEW of the 11th ult., the first electric tramway in Europe on the Thomson-Houston system was opened in Bremen on the 22nd June. The length of the line, which forms a double track, except in one narrow street, is 1,748 yards, or nearly a mile. It commences at the Town Hall in the centre of the town and passing by the new railway station, terminates at Exhibition-place just inside the town park, where an industrial exhibition is now being held. The conductors, which are carried overhead, consist of copper wires 8.25 mm. in thickness, and are suspended from insulators attached to steel cables arranged transversely across the streets on steel and cast iron posts. The engine-house is situated about 220 yards from the starting point of the tramway and to the left side of the park entrance. It contains at present a Pétry-Déreux boiler, and a steam engine of 150 I.H.P., made by Küchen of Dusseldorf. This drives a dynamo having an output of 62,500 watts, at an E.M.F. of 500 volts at the terminals. There is also installed a 70 H.P. high speed Armington-Sims engine, and an arc light dynamo. Another dynamo, similar to the first, will shortly be erected. Current from this generating station is used for several purposes: for the working of the tramway; for operating a 15 H.P. electromotor placed in the Vienna Bakery in Exhibition-place, where the motor actuates several kneading machines, and a dynamo which supplies current to a number of arc and incandescent lamps; and for the lighting of many arc and glow lamps arranged on the tramway route, &c.

The current from the first dynamo goes from the positive brush to the main conductor, which is arranged at a height of 20 feet over the middle of the track and passes along it until it reaches a contact roller carried by the car. The current is collected by contact rollers, from which it passes to the two motors, then through the car wheels to the rails and thence back to the negative brush. It branches its course along the main conductor and is collected by the contact rollers on other cars in the same manner. The single rails are connected by copper wires rivetted to them. On the top of each car is erected, at an angle of 40 degrees, an iron supporting rod which carries a grooved contact roller pressing against the underside of the conductor. Suitable leading devices are arranged at crossings so that the contact rollers keep in position. There are two 10 H.P. motors to each car and they are fixed in a specially built framework. Each motor drives one of the two axles, and each car is fitted with brakes, track brushes for removing obstacles off the rails, and safety appliances. Throughout the line there are numerous curves most of which are of small radius, but these are all traversed with great facility. At present there are in service five to six passenger cars, to each of which a separate car can be attached according to the requirements of the traffic. A car dépôt has been erected in the rear of the gas works and several pits have been dug in order to render the motors readily accessible.

—Abstracted from the *Elektrotechnische Zeitschrift*.

## FIELD'S MAKE AND BREAK TELEPHONE.

MR. STEPHEN W. FIELD'S work in the various branches of telegraphy and electric railroading is probably well known to our readers, but his versatile genius has also led him in the direction of telephony. One of the results of his work here has been the production of a telephone which automatically makes and breaks its circuit with a rapidity too great to be perceptible to the ear; he combines this with a diaphragm in such a way that sound waves projected against it are caused to bridge over the makes and breaks to a degree exactly proportional to the sound waves' rapidity of succession.

The accompanying engraving, fig. 1, shows two such diaphragms, D and M, supporting respectively two contact points, E and G. One diaphragm is supported above the other, and is kept in a state of tension by connection with a fine wire, C, of considerable resistance.

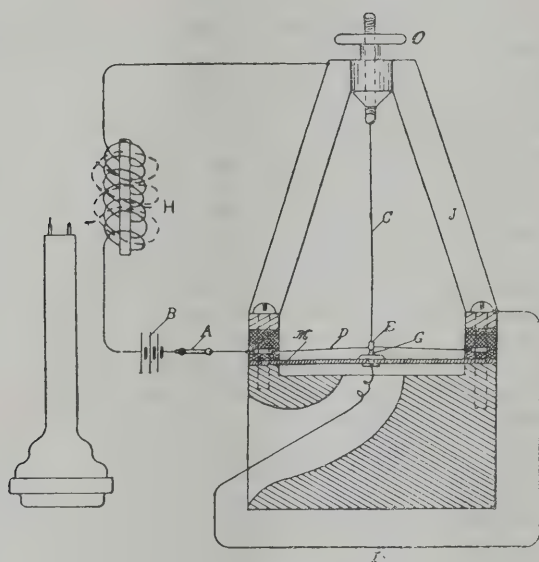


FIG. 1.

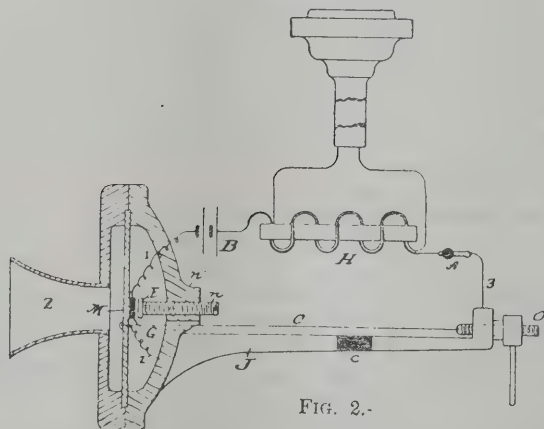


FIG. 2.-

It will be seen that the circuit of battery, B, passes normally through the insulated metal frame, J, of the telephone, and the wire, C, to the diaphragm, D. It will also be observed that there is a short circuit, by way of the wire, I, between the contact point, G, and the frame, J. The strain of the wire, C, is normally sufficient to separate the contact points, E and G, but when the switch, A, is closed and the current from battery, B, traverses wire, C, the latter will elongate and allow the points to come in contact. The current will thus be shunted around wire, C, through a path of approximately no resistance, with the result of cooling and contracting C and separating the contact points.

The function of the device is, in fact, that of a circuit-breaker of such rapid action under the influence of the current of the battery, B, that the vibrations are outside the receptivity of the ear. It follows that the sound waves striking the diaphragm, F, will alter the relative positions of E and G, and tend to prolong their contacts,

making audible, and, if in proper sequence, articulate speech.

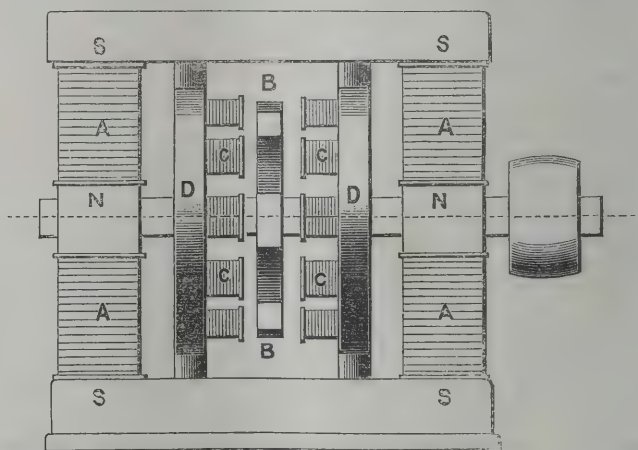
In fig. 2 is shown an arrangement for applying the same idea to a carbon transmitter for the purpose of increasing its sensitiveness. In this construction the carbon, which is mounted on the diaphragm, is kept in contact with a corresponding platinum contact piece by means of a fine wire under tension attached to the diaphragm. The contact expands the wire C, thereby tending to break the circuit; but the consequent cooling of the wire contracts the same and closes the circuit.

With the construction here illustrated an equilibrium is set up between the elongation of the wire, C, and the resistance at the carbon contact, the result being that the pressure of the carbon is kept automatically at the most delicate point and a self-adjusting carbon transmitter is obtained. The changed thermostatic condition of the primary circuit is brought about in this construction by a rupture of the circuit, due to the elongation of the resistance wire, or, rather, by an increase in the resistance of the circuit, and not, as in the other form, by the introduction of a shunt around the resistance wire.

The makes and breaks of the automatic circuit breaker produce no audible effects upon the circuit by reason of the great rapidity with which they follow each other. That is to say, the normal vibrations of the circuit breaker, considered with respect to their capacity to reproduce sounds, are neutral or inharmonious. That which reduces them to harmony and enables them to reproduce sounds is the combination, with the apparatus which produces them, of devices which bridge over or throw together more or fewer of the inharmonious vibrations and thus alter their natural sequence.

## AN HISTORICAL ALTERNATOR.

BY the courtesy of Messrs. Paterson and Cooper, we are enabled to give here a sketch of the Lever Alternating Current Dynamo, to which reference was made last week in our leading columns. On the two upright magnets, which also serve to carry the bearings for the star wheel, B, are four magnetising coils, A. The spokes of the wheel are eight in number, and there are 32 fixed coils, C (a few of which are shown), 16 being



arranged on each side of the wheel. The coil cores are fastened into the ring cheeks, D, D, while the whole is bound rigidly together by the sole and top plates, S, S. All the wheel spokes are of similar polarity, as the current circulates in the magnetising coils to produce poles, N and S, as marked. The sketch really explains itself, and the faults of the design will be as obvious as the resemblances to Prof. Elihu Thomson's machine described last week. The substitution in the latter of one circle of radiating coils for the two circles in Lever's is a distinct improvement, as is also the winding of the magnetising coils concentric with the axis, and employing two instead of four. The necessity for laminating the magnet wheel is one of the things that

Lever would have found necessary had he gone on with his machine. That he did not follow his ideas a little farther is a circumstance to be regretted, as it is highly probable that the process of evolution to which all new designs are subject would have produced a machine nearly similar in detail as it was in principle to the latest American novelty.

### THE MUNICIPAL ELECTRICAL WORKS AT TRIENT.

[FROM A CORRESPONDENT.]

THE following particulars are given on good authority concerning the electric illumination of Trient and the cost of the installation. The works are driven by water-power, and were erected by Siemens and Halske. The municipality of Trient has already paid upwards of 500,000 florins for the arrangement of the present water-power of the Fersina, amounting to 600 H.P., and in order to make sure of this power during the time when the river is low, they will have to tap the lakes on the Pine, which lie at the distance of 12 kilometers up the valley, so as to utilise them for making up the water supply if deficient, which with all the additional rights to be acquired, will involve a fourth outlay of at least 150,000 florins. The town, with a population of 20,000, expends, therefore, more than 650,000 florins for its electrical works, to supply 6,000 glow lamps or their equivalent in arc lights or in power. Already 4,450 glow lamps and 30 arc lamps are set up, and there still remains 120 H.P. for the transportation of power. Of the latter, 50 H.P. are already disposed of, and the residue will soon be required, in consequence of the unusually favourable conditions proposed, so that the entire installation will soon be in full work.

If we look at the financial phase of the question, we see a surprising result. Deducting the 440 glow lamps and the 30 arc lamps for street lighting, the income of the town from the undertaking is :—

For 4,000 glow lamps at 12 candles average at 50 kreuzer per month, or 6 florins yearly	24,000 florins
For hire of 120 H.P. at 10 florins yearly	4,800 „
Total	28,800 „

But the town has to meet the following outlay :—

Management, working and main- tenance, according to the ex- perience of similar installations	18,400 florins
Interest on capital	26,000 „
Sinking fund and money necessary to be written off, including de- preciation at 0.5 and 5 per cent...	17,875 „
Outlay, total	62,275 „
Deduct returns	28,800 „
Deficiency	33,475 „

which the city has to charge to the account of public lighting.

Hitherto the city has paid for public lighting :—

Gas	8,600 florins
Petroleum, in outward radius	2,000 „
Total	10,600 „

The town will expend therefore in future more than three times as much for public lighting as heretofore. It must be remembered that the change has been from gas to electricity, which, under favourable circumstances, produces no increased outlay, and is sometimes even a saving. It must further be considered that Trient is by no means a wealthy city, and that it now raises 180 per cent. of the imperial taxation as a com-

munal tax. Surely, many a city may take an example and indulge in a luxurious system of lighting! But we must add that the estimate for the electric lighting of Trient was, originally, only 210,000 florins, and the abnormal cost of execution was by no means the intention of the Trient municipality.

### COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

THE Vienna International Electrical Company has applied to the authorities at Buda-Pest for a concession to erect and work an electrical works for supplying electricity for illumination, the conveyance of mechanical power, and other industrial purposes. The company apply for the concession for 50 years, after which time the entire works are to pass gratuitously into the possession of the city. But it is open to the municipality to terminate the agreement after the lapse of 20 or 30 years, that is to say, after 20 years, on a payment of 20 per cent. above the valuation, or at the end of 30 years simply at the valuation. For the right of using the public streets to lay down the cable leads, the company would pay the municipality 3 per cent. of the gross returns. It is to be presumed that the capital of Hungary will at last come into the possession of electrical works.

In the Hungarian port, Fiume, proposals were requested for the erection of a mechanical elevator at the railway station. Electrical motors are proposed, which are to be supplied with current from the works projected for the illumination of Fiume.

At present telephone central stations are being erected in the cities of Fiume, Raab, Oedenburg, and Esseg. Several extensive landowners are also connecting the buildings on their possessions with telephonic sets. The company, for regulating the river Raba, is doing the same, and is connecting the various stations on their regulating line by telephones constructed by Egger and Co., of Buda-Pest.

The last weeks have been characterised by violent thunderstorms, especially in the mountainous parts of Austria, and several falls of lightning are reported.

At Marienbad the lightning struck repeatedly in two successive nights at various parts of the overhead leads of the electrical works. The machines were deprived of current after the strokes, but were not further damaged, and have since worked correctly. It is announced from Villach that in the night, between the 4th and the 5th of the current month, one storm followed another from 9 p.m. to 6 a.m. Flash followed flash, the thunder was unceasing, and the rain and hail destroyed the residue of the crops. Ten times the lightning fell in the city and suburbs. Two strokes followed each other in quick succession along the lightning rod of the tower of the parish church and destroyed the apparatus upon it and the one below it in the police watch-house, where the officer on duty was rendered unconscious. Another flash struck the house of General Six, tearing down the tiles and the timbers of the roof. Further flashes struck the railway bridge over the Drau, some trees, and an Alpine hut, which was burnt down. According to report, buildings were set on fire in the same night at Tarsis and St. Veil. The church-tower of Leopoldskirchen, which, like most of the towers in Corinthia, had no conductor, was burnt to ashes. On July 31st, two towers were fired by lightning at Lavamünd, and at Kolnitz two bells were melted and one shattered. In the afternoon two more storms burst over Villach. During the second a woman was killed. In consequence of the torrents of rain, the Drau has risen three metres and caused much damage.

The Hungarian Minister of Commerce has granted a concession for laying down the leads for the electrical works at Karanseles, which will be carried out with alternating current transformers at a tension of 2,000

volts. This is the first concession granted by the Hungarian Ministry for such an installation, and the conditions of the concession will be a standard for the erection of overhead leads of high-tension transformers.

The conditions prescribed are as follows :—  
1. The aerial leads must not be stretched too tightly. At 20° Centigrade they must not be strained above one-third of their total tenacity, and wires of less than 3 mm. in diameter must not be used.

2. The heating of the wires by the current must not exceed 20° C.  
3. The leads must be fixed upon rod supports in such a manner that the wires run at least two metres above the roof. If this is not possible, they must be conducted at least 6 metres above the roadway.  
4. Where lighting wires and telegraph wires cross each other, the former must be at least 2 metres higher than the latter, and due precaution must be taken to prevent these respective wires coming in contact.

INTERRUPTIONS AND REPAIRS TO SUBMARINE CABLES, 1888–1889.

Name of Comp.ny.	Section.	Interrupted.	Repaired.	Number of days interrupted.	Total for each section.
African Direct (2,743 N.M.) ... ..	Sao Vicente—Sao Thiago ... ..	2nd Jan., 1888	2nd Feb., 1888	31	31
	Sierra Leone—Accra ... ..	11th Oct., 1888	20th Oct., 1888	9	9
	Accra—Lagos ... ..	25th July, 1888	8th Sept., 1888	45	45
	Lagos—Brass ... ..	?	15th May, 1889	?	?
Anglo-American (10,196 N.M.) ... ..	Brest—St. Pierre ... ..	24th Sept. 1888	1st Oct., 1888	7	
	" " ... ..	18th July, 1889	6th Sept., 1889	49	
	" " ... ..	18th Nov., 1889	12th Dec., 1889	24	80
	Constantinople—Odessa ... ..	29th Feb., 1888	5th April, 1888	36	
Black Sea (346 N.M.) ... ..	" " ... ..	12th Jan., 1889	21st Feb., 1889	40	76
Brazilian Submarine (7,326 N.M.) ... ..	Lisbon—Madeira ... ..	1st Sept., 1888	3rd Sept., 1888	2	2
Central and South American (3,178 N.M.)	San Juan del Sur—Panama ... ..	4th June, 1889	5th June, 1889	1	
	" " ... ..	29th July, 1889	7th Aug., 1889	9	10
	Santa Elena—Payta ... ..	15th May, 1889	21st May, 1889	6	6
	Gibraltar—Tangiers ... ..	29th Dec., 1887	30th Dec., 1887	1	
Eastern (21,859 N.M.) ... ..	" " ... ..	10th Sept., 1889	23rd Sept., 1889	13	14
	Chio—Tenedos ... ..	13th Nov., 1888	20th Nov., 1888	7	7
	Suez—Suakim ... ..	6th Mar., 1888	5th April, 1888	29	
	" " ... ..	21st Nov., 1888	27th Nov., 1888	6	35
	Suakim—Perim ... ..	6th Mar., 1888	20th Mar., 1888	14	
	" " ... ..	21st Nov., 1888	11th Dec., 1888	20	34
	Aden—Bombay ... ..	11th July, 1888	11th Sept., 1888	62	62
	Saigon—Hongkong ... ..	28th April, 1888	7th May, 1888	9	9
	Haiphong—Hongkong ... ..	28th April, 1888	30th April, 1888	2	
	" " ... ..	7th May, 1888	11th May, 1888	4	6
Eastern Extension (12,958) ... ..	Banjoewangie—Port Darwin ... ..	30th June, 1888	18th July, 1888	20	
	" " ... ..	10th Oct., 1888	15th Oct., 1888	5	
	" " ... ..	22nd Oct., 1888	29th Oct., 1888	7	32
	Australia—New Zealand ... ..	9th Aug., 1888	20th Aug., 1889	11	11
	Mossamids—Port Nolloth ... ..	1st July, 1889	7th Aug., 1889	37	37
	Shanghai—Nagasaki ... ..	8th July, 1888	14th Aug., 1888	37	37
	Milazzo—Lipari ... ..	29th Nov., 1888	11th Dec., 1888	12	
	" " ... ..	14th Sept., 1889	23rd Sep., 1889	9	21
	Assab—Massowah ... ..	13th June, 1889	18th June, 1889	5	5
	Galveston—Tampico ... ..	28th June, 1888	20th July, 1888	22	22
River Plate (32 N.M.) ... ..	Monte Video—Buenos Ayres ... ..	10th Oct., 1889	14th Oct., 1889	4	4
Spanish Government (135 N.M.) ... ..	Javea—Ibiza ... ..	11th Feb., 1888	20th Sep., 1888	224	224
Turkish Government (331 N.M.) ... ..	Dardanelles—Pera ... ..	30th Dec., 1887	4th Jan., 1888	5	5
	Suakim—Djedda ... ..	10th May, 1889	21st May, 1889	11	11
West African (3,015 N.M.) ... ..	Balama—Bissao ... ..	2nd May, 1888	28th Aug., 1888	118	118
Western and Brazilian (3,761 N.M.) ... ..	Para-Maranham ... ..	4th April, 1888	16th April, 1888	12	
	" " ... ..	6th Sept., 1888	24th Sept., 1888	18	
	" " ... ..	2nd Nov., 1888	14th Nov., 1888	12	
	" " ... ..	21st May, 1889	4th June 1889	14	56
	Maranhm—Ceará ... ..	3rd Jan., 1888	16th April, 1888	44	
	" " ... ..	27th May, 1889	31st May, 1889	4	48
	Pernambuco—Bahia ... ..	1st April, 1889	20th April, 1889	19	
	" " ... ..	20th July, 1889	27th July, 1889	7	26
	Bahia—Rio de Janeiro ... ..	12th Jan., 1888	9th Feb., 1888	28	
	" " ... ..	30th Jan., 1889	5th Feb., 1889	6	
	" " ... ..	3rd Sept. 1889	18th Sept., 1889	15	
	" " ... ..	21st Sept. 1889	6th Oct., 1889	15	64
	Rio de Janeiro—Santos ... ..	16th April, 1889	25th April, 1889	9	9
	Santos—Santa Catarina ... ..	18th Oct., 1889	24th Oct., 1889	6	6
	Rio Grande do Sul—Monte Video	25th April, 1889	11th May, 1889	16	
	" " ... ..	11th June, 1889	27th June, 1889	16	
	" " ... ..	4th Dec., 1889	6th Dec., 1889	2	34
	Chorillos—Mollendo ... ..	11th Dec., 1888	20th Dec., 1888	9	
	" " ... ..	19th July, 1889	25th July 1889	6	15
	Jamaica—Colon ... ..	5th Nov., 1887	31st Jan., 1888	56	
West India and Panama (4,119 N.M.) ...	" " ... ..	22nd Dec., 1888	19th Jan., 1889	28	84
	St. Vincent—Barbadoes ... ..	13th Feb., 1888	8th Mar., 1888	26	
	" " ... ..	12th April, 1888	18th April, 1888	6	
	" " ... ..	12th May, 1888	22nd May, 1888	10	
	" " ... ..	19th Jan., 1889	26th Jan., 1889	7	49
	Trinidad—Demerara ... ..	5th Nov., 1888	12th Nov. 1888	7	
	" " ... ..	13th Dec., 1888	27th Dec., 1888	14	
	" " ... ..	3rd Feb., 1889	9th Feb., 1889	6	
	" " ... ..	20th Mar., 1889	22nd Mar., 1889	2	
	" " ... ..	23rd May, 1889	6th June 1889	14	
Western Union (5,537 N.M.) ... ..	" " ... ..	19th Dec., 1889	7th Jan., 1890	19	62
	Atlantic ... ..	12th Sept., 1889	2nd Jan., 1890	112	112
	Punta Rassa—Cay West ... ..	4th June 1888	5th June, 1888	1	
	" " ... ..	5th Jan., 1889	18th Jan., 1889	13	
	" " ... ..	29th Jan., 1889	12th Feb., 1889	14	28

# AN ACCOUNT OF SOME EXPERIMENTS UPON THE APPLICATION OF ELECTRICAL ENDOS- MOSE TO THE TREATMENT OF GOUTY CON- CRETION.

Presented to the International Medical Congress at Berlin by  
THOMAS A. EDISON, of New York.

HAVING ascertained that gouty concretions are in many cases medically treated with the aid of lithium salts taken internally, with the object of causing urate of lithium to be formed, dissolved, and excreted from the body; and being also informed that the difficulty met with in the treatment was in ensuring that the salts so administered should be absorbed into the system, it occurred to me that perhaps more rapid success might be obtained if the application were made externally, employing the well known principle of electrical endosmose to carry the lithium into the tissues. This method of operation appeared to offer considerable hope of success, because the lithium would be brought directly into the neighbourhood of the concretions and would thus be more likely to act promptly and effectively.

Electrical endosmose, as the name implies, is that property of an electrical current passing through a porous diaphragm between two solutions, in virtue of which one solution is mechanically transferred across the barrier. The current seems, in fact, to accelerate the diffusion which always takes place between solutions separated by a porous diaphragm, and at the same time acts in one direction, the solution being carried from the positive to the negative pole, from the anode to the cathode. A full description of the phenomenon is given in Wiedemann's "Die Lehre von der Elektrizität."

To test the possibility of causing lithium salts to pass in this way through an animal membrane, I made the following experiment:—

A glass funnel of 7.5 centimetres diameter at aperture was closed by a piece of sheep bladder 0.012 cm. thick, thus providing a porous diaphragm of 44 sq. cms. area. This funnel was inverted and filled with slightly acidulated water, and a platinum wire passing down the tube formed the negative electrode. The whole was then immersed about 1 cm. below the surface of a 2½ per cent. solution of  $\text{Li}_2\text{O}$ , contained in an evaporating dish above the bottom of which it was supported about 1.25 cms. Immediately after immersion, a second platinum wire forming the positive electrode was dipped in the dish, and a current of 150 milliamperes sustained steadily through the apparatus for 75 minutes. The funnel was then removed and emptied. Its contents were mixed with a solution of  $\text{NaPO}_3$ , and the mixture evaporated to dryness. The residue was then treated with water to dissolve the sodium salt and then left for 12 hours. The final precipitate was found to contain 0.5 gramme of  $\text{LiPO}_3$ .

The experiment was then repeated under precisely similar conditions except that no current was passed through the apparatus and diffusion only could be active in transferring the salt. The analysis in this case showed that 0.3 gramme of lithium phosphate was present, from which it was presumed that in the previous instance the current had increased the diffusion transfer to the extent of 67 per cent.

Finding the experiment succeed with a membrane, I next tried whether a healthy man, after being subjected to such a course of treatment as a patient suffering from concretions might be expected to undergo, would not give indications of the absorption of lithium in his excretions. In October, 1889, J. D., an active healthy labourer, aged 20, and of 140 lbs. weight, was operated upon in my laboratory. He sat in a chair and kept his hands immersed to the wrists in glass jars, one containing a solution of 2 per cent. lithium chloride with a platinum electrode, and the other containing a solution

of common salt with the negative electrode. The current passed through him was 4 milliamperes, which was as much as he could conveniently stand. This treatment was continued for about two hours daily during one week, the total time of application amounting to 11 hours. His urine was collected during that week, and tests were then applied to it. Using a particular spectroscope and method, it was found that a solution containing  $\frac{1}{40000}$ th part by weight of  $\text{LiCl}$  in water was just detectable by a faint red band in the spectrum. No such band could under these circumstances be discerned from the urine itself, but a condensation of all the week's urine reduced to the form of chloride gave a distinct band. An evaporation of  $\frac{2}{5}$ ths of the total quantity of this liquid yielded on analysis 0.22 gramme of lithium chloride, and it was therefore presumed that the whole amount of salt excreted was 0.55 gramme, corresponding to 0.09 gramme of metallic lithium, or equivalent to the removal of 2.43 grammes of uric acid.

I next tried the application of the method to a patient suffering from an acute and typical form of the malady, in December, 1889. This person volunteered to try the effect of the method. He was 73 years of age, and had lived an active healthy life until ten years previously, at which time, according to his own statement, he contracted the disease through sleeping in damp sheets. Concretions commencing continued to increase slowly until they assumed large proportions. All the joints, except the knees, were much enlarged by atheromatous concretions. A certain degree of venous congestion was visible in his face, and incessant pain had supervened in various parts of the body during the last few months, apparently from the pressure of the calculi upon the nerves. The joints of the fingers were almost obliterated by concretion.

The girth of the little finger of the left hand was, by careful measurement, 8.6 cms., that of the corresponding finger on the right hand even greater. There was great weakness and difficulty in walking, but the mind was clear, and intelligence unimpaired.

Treatment was commenced in the manner above described. The current generated from my laboratory 120 volt dynamo, passed through about 5,000 ohms resistance, and entered a jar containing an aqueous solution of lithium chloride, density 1.08, in which the patient immersed his left hand up to the wrist. His right hand was similarly immersed in a solution of common salt. The current, after passing through his body, left the latter jar by a negative electrode. It was found that he could stand 20 milliamperes without inconvenience, and this strength of current was steadily applied for six days during four hours daily. At the end of that time the girth of the left hand little finger was distinctly reduced to 8.2 cms.; the patient also experienced freedom from pain after the first day's treatment. He continued the treatment for two days more during the week following, and then the journey to and from the laboratory exhausted his strength. The finger girth, after 14 days from the date of commencing treatment, was 8.0 cms., a total reduction of 0.6 cm. This was estimated to represent a reduction of 3 cm. of concretion on this particular finger, whose form facilitated accurate measurement. His general condition, beyond the weakness resulting from unaccustomed journeying, was temporarily ameliorated.

From these experiments, I think it fair to conclude that satisfactory use can be made of the principle of electrical endosmose in such cases.

It should be mentioned that lithia was first tried in the bath solution, and given up on account of its caustic effects. Even an aqueous solution of 1 per cent. of lithia was found to blister the hands after some continued immersion. It would, therefore, have been necessary to employ a very weak solution, had its use been retained, with a correspondingly lengthened course of treatment, but time did not allow of. The chloride was used in the expectation that it would be decomposed within the cuticle during the act of endosmose by electrolytic action, or that, failing this, it would enter into a direct combination with the uric acid,

## NOTES.

**Voltaic Battery with Iron Electrode in Pure Water.**—The *Comptes Rendus* of the French Academy of Sciences for 1862, page 700, describes Gerardin's battery, in which the zinc is replaced by a mass of iron filings, and an iron bar inserted into said filings, both being placed in pure water. The other electrode is of carbon, and is placed in a porous cup containing a solution of perchloride of iron and nitro-muriatic acid. This is a pertinent reference for the d'Humy primary battery, as it fully discloses an iron electrode placed in pure water.

**Dynamos in Central Stations.**—We notice in the issue of *Industries* for August 15th, the first instalment of a paper by Mr. James Swinburne, on the "Coupling and Control of Dynamos in Central Stations." The subject, and its method of treatment, are alike interesting; there is plenty of room for an article of this description.

**The Telephone in the West Indies.**—The Spanish Minister of the Colonies has received authorisation to grant concessions for establishing telephonic communications in the Islands of Cuba, Puerto-Rico, and the Phillipines.

**The Spanish Atlantic Cable Again.**—Once more has this annual blossomed. Whether a crop of fruit will be obtained is another question. We learn that the Spanish Minister of the Colonies has again offered that hardy plant, the direct cable between Spain and the West Indies, to public tender.

#### Recent Interruptions and Repairs to Submarine Cables and Land Lines.

Section.	Interrupted.	Repaired.
Cable Benzuela—Mossamedes ...	16 June, 1890,	2 July, 1890.
" Suez—Suakim ...	9 May	" 9 "
" Jamaica—Colon ...	15 July	" still interrupted
" Banjoewangie—Port Darwin 11	"	" 20 July, 1890
" Banjoewangie—Roebuck Bay, 11	"	" still interrupted
" Hongkong—Foochow ...	21 "	" "
" Amoy—Shanghai ...	21 "	" "
" Maranham—Para ...	24 "	" "
Land Lines, Transandine ...	10 "	" 11 July, 1890
" " Siberian ...	15 "	" 15 "

**Private House Lighting.**—The lighting of the "Manor House," near Twyford, has just been completed for W. L. Beale, Esq. The installation consists of an eight horse Priestman's oil engine, Crompton dynamo, and 53 E.P.S. cells, with about 120 incandescent lamps, and shortly the current will be utilised to pump water for the house. It is hardly necessary to say that the light gives the greatest satisfaction. The work of the installation was carried out by Mr. W. V. Scott, under the instructions of B. R. Beale, Esq., of Messrs. Crompton and Co., Limited.

**Electric Lighting at Woolwich.**—As anticipated, the Woolwich Local Board of Health has given consent to the Woolwich District Electric Light Company for the lighting of the town by the electric light.

**Electric Lighting at Canterbury.**—The Canterbury Corporation has passed a resolution in favour of making application to the Board of Trade for a provisional order to supply electricity for public and private purposes in the City and Borough of Canterbury.

**New Spanish Cable.**—The *Official Gazette* of Madrid, under date of August 18th, publishes an official announcement inviting tenders for the construction and laying of cables between Tarifa and Tangier, Tarifa and Centa, Almeria and Melilla, and other Spanish possessions on the coast of Morocco.

**A New Use for Rubber.**—We learn that the municipal authorities of Brussels have decided to experiment upon the new compound called "caoutchouc macadam." A portion of the Boulevard Anspach is being paved with this material. The compound consists of a mixture of India-rubber and different kinds of stones, ground up together, and thus converted into a sort of cement by means of heat. The material is stated to be hard, elastic, and durable, and to be unchanged by either heat or cold. If the mixture possesses the properties claimed for it we should fancy that it would be pre-eminently suitable for running tracks, and lawn tennis courts.

**Electric Railway in Sweden.**—We have to chronicle the construction of an electric railway at Boxholme, Sweden. It is intended for the carriage of manufactured articles from the ironworks to the store-houses. The motive power is a 50 H.P. turbine, working two of Wenström's dynamos. This railway is, we believe, the first of its kind in Sweden.

**The New Thomson Dynamo.**—A communication from Prof. Thomson to the *Electrical World* gives some interesting facts concerning his new dynamo, described in our last issue. It will be remembered that the principal electrical characteristic of the machine was absence of hysteresis in any marked amount, while the construction adopted possesses the great advantage of requiring no revolving wire. The construction of the machine has actually been simplified, even beyond the point shown in our illustrations, so that it is exceedingly easy to construct and prepare. Several have already been built—most of them of similar size, and one of them for alternations as rapid as 2,500 complete reversals per second. The construction of the machine as a dynamo lends itself very easily to obtaining such high rates of alternation as are rendered highly desirable in certain classes of work. If the suggestion referred to some time since, of making transformers without iron cores, is ever carried out this new Thomson dynamo should come into play with beautiful effect. Of course, in a converter without iron, very high alterations are absolutely necessary to economical and efficient construction; but the advantages to be gained are great enough to make it a very interesting subject for experiment. In such case it should be noticed that any dynamo in which the magnetisation of a considerable mass of iron is reversed at each alternation is practically excluded from use, since hysteresis would rise to an enormous amount, while the present machine, from almost complete absence of hysteresis, is admirably fitted for the purpose. A 1,000-light dynamo of the new form has already been constructed, and is in process of testing. It has shown remarkably good results, and it is specially noticeable that the iron is free from heating, and the efficiency eminently satisfactory. A still larger machine is being planned, and there seems to be no good reason why the capacity may not be increased almost indefinitely.

**Electric Light and the Daily Press.**—Our bright little pink contemporary, we don't mean the *Sporting Times*, but the "*Globe*," a few evenings since had a somewhat superficial article on the subject of electric light in churches. It seems to think, and says, "The ladies are by no means unanimous in its favour, for it does not always add to the beauty of the complexion;" in this respect the writer of the roseate one's article appears to share the ignorance of the ladies when discussing the same subject, for at St. Jude's Church, of the illumination of which he is speaking, the lighting is to be by incandescence lamps of 8 candle-power and not by arc lights, which are well known to give a cold effect to the tone of even the most radiant faces. Again he says, "A church which is all glare from beginning to end—in every corner—is not acceptable to everybody;" just so! but we do not consider that glare is usually to be dreaded when 8 candle-power lamps are to be employed in a spacious building.

**A Trifling Request.**—Will some kind friend, who is not an editor, and who, therefore, may find time hang heavily on his hands, answer the following questions which an Indian subscriber has forwarded to us:—Could you inform me of what is the portable battery of four cells for electric lighting, by J. Pitkin, maker and patentee, made, and with what charged? In making a horseshoe magnet, what is the minimum distance the poles or ends should be apart? What would be the result or effect of their being brought very near, short of actual contact? If a Siemens' relay were fitted with larger slots or shoes, so as to extend, as it were, the whole length of the tongue, what advantage would there be, if any? In the differential system of duplex, double current, translation with Siemens' relays, does the want of insulation between the cores and the brass cylinder, and hence between the rest and working stops of the relay, and the cores when the tongue is either in the rest or working position, interfere with the efficiency of the relay in direct translation? How can the following fault be localised? A line is in contact with another which is worked in "closed circuit," and over which the testing station has no control, supposing a "loop" with another available line possible.

**Ryde Electric Railway.**—On the last Bank Holiday over 6,000 persons were carried along the electric railway on Ryde Pier.

**National Electric Light Association.**—The meetings commenced on Tuesday, and were to terminate yesterday. Among the papers read were the following, a selection of which will be given in a subsequent issue. "Electric Light as Supplied to Steam Railroads," W. H. Markland, Altoona, Pa. "Triple Expansion High-speed Engines for Central Station Work," E. F. Williams, Beloit, Wis. "Ferranti Station, London, England," Caryl Haskings, Lynn, Mass. "The Proper Care and Management of Alternating Currents," T. Carpenter Smith, Philadelphia. "Distribution of Energy by Alternating Currents and Transformers, and the Proper Method of Proportioning Conductors," A. H. Rohrer, Lynn, Mass. "The Proper Basis for Determining Electric Motor Rates," H. L. Lufkin, New York. "Actual cost of furnishing Arc Lighting (1,200 C.P., and 2,000 C.P. Lamps) under the Best Possible Conditions," J. C. Ayer, St. Louis. "Municipal Ownership of Electric Lighting Plants," M. J. Francisco, Rutland, Vt. "Accidents in Electric Lighting Stations and Plants," Prof. Charles R. Cross, Boston. "Care and Labour in Electric Light Stations and its Value," A. J. DeCamp, Philadelphia. In addition to these papers, various reports were to be considered.

**The Joke of the P.O. Electrician.**—Speaking of the recent scientific joke, our contemporary, the *New York Electrical World*, says:—The principal London electrical papers escaped unscathed, but the small fry, and some large enough to know better, were with one accord taken in. As might have been expected, when it transpired that the supposed invention was a hoax, the victims were somewhat demoralised, and while some of them preserved a discreet silence, others waxed wroth and growled out protests.

**The Lane-Fox Patents.**—In connection with this a meeting was held last week of various firms interested, and it was resolved to form an association on the lines of the circular published in the *REVIEW* on August 8th.

**The Volta Electrical Company, Limited.**—Creditors of the company are to send their names and addresses of their solicitors, if any, and particulars of debts and claims to Mr. Thos. Browett, Sandon Engine Works, Salford, Manchester, the liquidator, on or before 19th September next, or to be excluded from any distribution made before such debts or claims are proved.

**An Extraordinary Robbery.**—A correspondent of a daily paper states a most extraordinary case of robbery in Paris. Six thousand metres of cable had disappeared from the Champ-de-Mars, while at the other end of the city, in the Avenue Daumesnil, near Vincennes, an exactly similar length of wire was missing. Furthermore, an inspector from the Post Office discovered that the cable between the Rue de Grenelle and the Rue de Villejust, as well as that connecting the Place de la République with the central markets, had been cut in different places. It appears that all this damage—which caused much delay, inconvenience, and complication—was done by two professional excavators or "navvies," named respectively Chartier and Haurant. These men, who probably had assisted in putting down the wires, were in the habit of carrying on their operations at night, when they descended into the drains or cuttings with dark lanterns, and carried away both the cables and their environments. The principal delinquents were each condemned to 15 months' imprisonment, while the receivers were sent to gaol for shorter periods—a salutary example being thus made of the destroyers of telephone wires, and one which, it is to be hoped, will prevent other ingenious persons from endeavouring to imitate the mischievous deeds of the scientific "navvy" and his colleague.

**Telephone Monopoly in Germany.**—The well-known Telephone Manufacturing Company, Actien Gesellschaft, Mix and Genest, has been successful in an action brought against the Government as to the building and maintaining of telephone lines. Previously the German Post Office succeeded in prohibiting all telephone installations erected by private companies. By the spirited action of the company this state of things has been entirely altered.

**Car Companies at Chicago.**—Two new car companies have been started at Chicago—the Columbia Street Car Manufacturing Company, capital, \$100,000, and the United States Electric Car Company, for the manufacture of electric cars, capital \$3,000,000.

**Fire at the Edison and Swan Factory.**—A fire broke out in the depositing rooms of the Edison and Swan Electric Factory, at Ponder's End, on Tuesday morning. This portion of the factory is divided from the remainder by a thick party wall of great height. The cause of the fire was the ignition of some benzoline used in the work. The fingers of the girl using the benzoline were hurt, but about fifty other girls, to whose benches the fire quickly spread, were got out of the place uninjured. The local fire brigade attended, but their efforts were confined to preventing the flames from spreading. They thus saved the remainder of the premises, but the depositing building was destroyed. The amount of the damage is not known, but it is very considerable.

**Percussion Cap Lightning Arrester.**—In a recently made American arrester ordinary percussion caps are employed to break the arc which so often follows the static discharge. The heat produced by the current when the arc is formed explodes the cap, thus blowing out the arc. It is said to work admirably in practice.

**Fan Motors.**—During the recent hot weather in America motors have been largely used for propelling fans.

**Tenders for Lighting.**—For lighting the parish of Heavitree with gas or electricity, for three years from 24th October. Full particulars from G. Havill, jun., Fore Street, Heavitree. Tenders to be deposited by the 30th. Tenders wanted, by 1st September, for lighting Kinsale, Ireland. Mr. Hegarty, Town Commissioners' Office.

**"Manganese-Steel."**—Mr. Hadfield, of the Hecla Works, has been awarded a gold medal by the Société d'Encouragement pour l'Industrie Nationale for an entirely new alloy of iron and manganese.

**The Claims of Primary Batteries.**—A company is now engaged in America exploiting a certain form of primary battery, and in its descriptive circular the main object appears to fascinate the gullible public by quoting the historical details of Jacobi's boat experiments on the Neva more than 50 years ago, and Professor Page's car trip in 1851. The climax is reached, however, when we see that the "eight horse-power machine on our car will develop more actual mechanical horse-power (as operated by the primary batteries) than the combined power of two 10-H.P. motors as now operated by the several dynamo methods." The example of George Washington is evidently emulated by but few inventors in the States.

**Award.**—A Gold Medal has been awarded by the Société d'Encouragement pour l'Industrie Nationale to M. Ducretet, of Paris, for his services to science and industry, amongst which may be noted a Wimshurst induction machine of great power and an ingenious device for reproducing Professor Elihu Thomson's experiments in connection with electro-dynamic repulsions and rotations.

**Alternating Currents Doomed.**—The Société Industrielle du Nord de la France has awarded a silver medal to M. Lafargue, for a note on the distribution of electric energy by alternating currents. M. Lafargue is of opinion that alternating currents will, sooner or later, fall into disuse.

**Electromotors and Weaving.**—MM. Chaize frères, weavers, of St. Etienne, have been awarded a gold medal by the Société d'Encouragement pour l'Industrie Nationale for an ingenious application of electromotors, which they have been using in their workshops for some time. The Société has also conferred a similar honour upon M. Monchère for an ingenious application of electricity to the reeling, weighing, and making up into balls, of silk and similar woven fabrics. A silver medal of the same Société has been awarded to M. Radiguet, of Paris, for his electric knitters for use in the hosiery trade.

**Obituary.**—*Electrical Industries* of America says:—Mr. James W. Queen, founder of the celebrated house of Jas. W. Queen & Co., 924, Chestnut Street, Philadelphia, died July 12th, at Cresson, Pa., where he was visiting in the hope of receiving benefit from the mountain air. Mr. Queen had reached the good age of 78 years. His name occupies a prominent place in the business records of Philadelphia, and most of the high class English and American houses were at one period represented by him in Philadelphia. His integrity was beyond question, and no one enjoyed a better reputation.

**Electric Lighting of Mines.**—M. Le Compte Gerson has presented the electric mining lamp, Stella, to the Academy of Sciences.

**Electric Lighting of the City.**—A Committee of the House of Commons confirmed the two provisional orders, granted to the Brush Electrical Engineering Company and the Laing, Wharton, and Down Construction Syndicate, for lighting the City. The area to the east of the Mansion House, Princes Street, and Moorgate Street is assigned to the Laing Construction Syndicate; and the area to the west of those points, as far as, and including, the north side of St. Paul's Churchyard, is assigned to the Brush Electrical Corporation. The orders have now been sanctioned by both Houses of Parliament.

**Cable Testing.**—Mr. C. H. Gray, of Silvertown, writing too late for our correspondence columns, says:—"The method described by Cuthbert Hall for localising faults, is practically the same as I employed eight or nine years ago at Persan for the same purpose, the only difference being that, instead of insulating the trough as he has done, I insulated the stand on which the hobbin containing the wire to be tested was supported. There is practically no difference between the methods, and both are simply improvements on Warren's old method of localising faults in core. The only advantage I can see in my method seems to be that in actual practice I used a long trough, and was thus able to travel at a considerably higher speed than could be attained with the short trough used by Cuthbert Hall. They are still, I believe, using the above method at Persan for localising faults in common bell-wire core."

**Gas and Electricity.**—Presiding at the half-yearly meeting of the Liverpool United Gas Light Company, on Tuesday, Mr. Edward Lawrence stated that so far as the application and use of electricity went, up to the present time he saw nothing to cause uneasiness to the proprietors of gas stock. It was quite true the consumption of electricity in Liverpool was increasing, but at the same time the consumption of gas had increased by 2 per cent., and he thought they might safely conclude that with other uses being found for gas the consumption would continue to be extended, while the use of electricity would also be increased.

**Foreign Wire Industry.**—The Italian Metallurgical Company is very busy just now with orders for electric wires.

**Bimetallic Conductors.**—The Administration of Posts and Telegraphs, France, is about to make a trial with the Durand system of bimetallic telegraph and telephone wires, composed of red copper with steel cores.

**The Manufacture of Electric Motors.**—As showing the great demand for motors, it is stated that the C. and C. Motor Company, of New York, have sold during the last six weeks 2,000 motors, which is equal to the sales of any previous year.

**Fire Office Rules.**—Major Flood Page, in a lengthy letter to the *Times* of yesterday, discusses the various fire rules of insurance companies. He had considered over twenty sets of rules, and came to the conclusion that the Phoenix Rules were the most acceptable in every way.

**Martignoni Disc Cutting Tools.**—The Machinery and Hardware Company of London, having obtained the sole right to manufacture the Martignoni patent disc cutting tools for lathes and general machine tools, have been demonstrating their value by showing them in actual work at their own show-rooms. These tools are expected to create quite a revolution in the turning and machine tool trade, as they are calculated to effect a saving of both time and material. They do away with the necessity for reforging or "fettling" tools, as the emery-wheel, in the hands of a boy, is sufficient to put a new edge on the tools in a few moments. There is no waste steel, and as vibration is avoided the machine can be run at a higher speed. No doubt many of our readers will be glad to have their attention called to this useful novelty, of which further particulars may be obtained on application to the company

**New Insulated Wire.**—We extract the following from the issue of the American *Electrical Engineer* for August 6th:—"The insulation of the American Circular Loom Company's wire, however, is not braided, but woven on by means of circular looms of improved type, the invention of Mr. Charles T. Stetson. The cotton is No. 12 single, and is twisted together at the factory in as many ply as is necessary for the size of wire to be covered. The twisted cotton is then put in the loom, which works exactly the same as looms for weaving flax fabrics, so many bobbins forming the woof, and so many bobbins being so shaped as to fit the shuttles which circulate round the loom and forming the warp. The looms are about four feet in diameter, and the mechanism is extremely simple and interesting to the eye of a mechanic. The shuttles move round very rapidly, the woof being moved up and down by means of eccentric rods on revolving discs, so that the warp passes below one thread and above the next one. When completed, the woven insulation is very hard and firm, and has the appearance of a canvas jacket, like a piece of sailcloth around the wire. The wire is then taken to the compounding house, where a special compound is forced into the cotton insulation by a secret process so effectually that every fibre of cotton is thoroughly impregnated. It is then polished and finished and wound on drums for shipment. When finished, the insulated wire has a peculiarly tough finish, and is particularly capable of withstanding a large amount of abrasion, and is at the same time as waterproof as any line wire with cotton fibre in the insulation can be, and is to a very extraordinary degree fireproof."

**Microphonic Phenomena.**—The paper which Mr. Tanner has courteously sent to us for publication on microphonic effects is exceedingly interesting, and will doubtless be appreciated by everybody engaged in telephonic pursuits. This gentleman has also unearthed the description of a battery, appearing amongst our "Notes," which anticipates the famous D'Humy cell, although the same feat has been previously accomplished by others.

**Submarine Telegraphy Threatened.**—It seems scarcely possible that the advent of electric railways should threaten a serious disturbance to signalling through long cables; yet the experiences of Mr. Cuttriss point to the possibility of grave complications arising from the proximity of heavily charged conductors interfering with telegraphic signals on the Atlantic cables. Probably, if this kind of thing develops so as to seriously interfere with business, an edict will be issued to prohibit any electric car running within a given distance of important telegraph lines, unless carrying its own motive power—in other words, it will be another argument in favour of accumulators.

**Good News for "Okonite" Shareholders.**—The Okonite Company, of New York and London, manufacturers of okonite insulated telegraph, telephone and electric light wires and cables, has completed its new factory at Passaic, N.J. It is an imposing three-storey brick building and employs 400 hands. The company is turning out on the average of 60 miles of okonite insulated wire per day, and is still a month behind its orders. It recently received an order for 1,000,000 feet of wire from the Chicago Edison Company, Chicago, Ill.

**Electricity and Poetry.**—There is a tendency among the Americans to fall into poetry when considering things electrical. Dr. Oliver Wendell Holmes has celebrated the electric car in a somewhat lengthy poem. He identifies the trolley poles as "witches' broomsticks," and, referring to the sparking, he says "we may see the gleam of her wicked eye."

**Electropathic Quackery.**—The *Hospital Gazette* says:—"It is high time measures were taken to stop the serious imposition practised on the public by a large body of men who—notwithstanding their professed ignorance of the first principles of anatomy, physiology, pathology, therapeutics, and electricity—set themselves up as experts, and largely advocate their worthless patents to credulous and easily-duped individuals, the majority of whom possess highly neurotic temperaments. Towards the suppression of such nefarious practice the press can exercise a mighty influence, and acquaint the public with the various ways they are being put upon by these tricksters and would-be benefactors to suffering humanity. The ELECTRICAL REVIEW, we are pleased to see, has taken a prominent lead in this suppression, and formed a committee for this purpose. It is to be hoped other journals, but more especially those which are circulated largely amongst the public, will imitate the example set them, and boldly denounce the frauds which are being daily practised on us. In taking such steps these journals will not only benefit society, but will place a salutary and lasting check on the methods and practices which must seriously impede the advancement of one of our most important sciences. Unfortunately, however, the majority of newspapers aid and abet the electrical quacks by publishing their advertisements and reports of alleged 'wonderful cures.'" The only remark we desire to make on this expression of opinion from the *Hospital Gazette* is, that the ELECTRICAL REVIEW is quite unconscious of the formation of any committee.

**Street Names Read at Night.**—It is said that the inspector of streets of St. Louis has adopted a novel method of marking the names of streets, so that the darkest night will not render the way difficult to find. The names of the streets are painted upon the electric light globes, and the shadow resulting throws the name upon the ground so plainly that it can be read 50 feet away. The letters on the globe are three-quarters of an inch, and the shadow is five feet wide. An arrangement of this nature would be a welcome one elsewhere.

**Mr. Edison as a Medical Electrician.**—The article which we print on page 213 shows Mr. Edison in a new character, one, indeed, in which we trust he may shine as brightly as he has hitherto done in the application of electricity to the industrial arts. The subject he has taken in hand is one of great importance, and will be duly appreciated by those who have suffered various degrees of torture from an excess of uric acid.

**Submarine Cables.**—The table of interruptions and repairs to submarine cables during 1888–1889, which we publish on another page, will be found of service to those interested in their manufacture, laying, and repair, as well as to the various telegraph companies. We expect that in the near future this table will be considerably elongated.

**Electric Lighting Statistics in North America.**—The following figures, which we cull from *Electrical Industries*, show to what enormous proportions the central station electric light industry has grown in North America. The number of stations is given as 1,379; the arc lamps in use as 137,441; the incandescents of 16 candle-power as 1,590,967; the engine capacity 356,755 H.P., and the capital invested as \$118,758,500.

**"Beneficent Murder."**—The *D.T.* has thrown open its columns, and the subject now discussed in a general way is the death of Kemmler. Mr. Buchanan is holding forth against what he calls cowardly experiments.

**Woodhouse and Rawson.**—We are informed that Woodhouse and Rawson United, Limited, have been awarded a silver medal for their show at the Exhibition of Fire and Life saving apparatus now being held at Amsterdam.

**Electricity and Ballooning.**—Electrical motors for use in ballooning are being manufactured at the Meudon military workshops on the plan invented by M. Renard. The importance of the discovery is said to be such that the details are kept strictly secret, although probably this is a greatly exaggerated version of the real facts.

## NEW COMPANIES REGISTERED.

**Nonpareil Electric Syndicate, Limited.**—Capital, £6,000, in £10 shares. Objects: To adopt an unregistered agreement of the 8th inst., between James Tarbottom Armstrong and Joseph Mason, of one part, and W. J. Smith (for this company), of the other part, relating to the purchase by the company of the letters patent granted to Joseph Mason for "a new or improved automatic coin-freed machine for giving electric shocks;" No. 1757, dated 11th October, 1889. Signatories (with one share each): J. Cunningham, 1, Maude Villas, Peckham; W. J. Smith, 29, Somerfield Road, N.; T. Sanders, 12, Dinsdale Road, Westcombe Park, S.E.; J. W. Jenner, 34, Millbank Street, S.W.; J. Willpress, 37, Hubert Grove, Stockwell; D. Capern, 139, Grosvenor Park, Camberwell; C. B. Woods, 37, Markham Square, Chelsea. Registered, 13th inst., without special articles, by A. R. Fowler, 2, Victoria Mansions, Westminster.

**Gordon Electric Traction Syndicate, Limited.**—Capital, £2,400, in £10 shares. Objects: To purchase the invention of John Gordon of a system of electric street car traction, provisionally protected, 5th May, 1890, No. 6,083. To purchase all future inventions of John Gordon suitable to the better application of the said invention. To develop the working of the invention, and in particular to carry on experiments at the works of Messrs. Merryweather and Sons, at Greenwich and elsewhere. Signatories: John Gordon, 13, Nettleton Road, New Cross, electrical engineer, 1 share; Wilhelm Luttge, 21, Lime Street, 14 shares; A. F. Koehel, 6, Fenchurch Street, 5 shares; J. C. Merryweather, Greenwich, 10 shares; E. Pascoe Williams, Blackheath, 10 shares; J. M. V. Money Kent, 34, Victoria Street, S.W., 10 shares; H. R. Goring, 17, Leadenhall Street, 10 shares. The signatories are the first directors, and Mr. Gordon is appointed managing director. Registered, 13th inst., by Gilbert Robins, 11, Pancras Lane.

**Trujillo Railway (Peru), Limited.**—Capital £500,000, in £1 shares. Objects: To acquire, construct, equip and maintain railways, tramways, telegraph and telephone lines in Peru, and to acquire the rights of the Peruvian Corporation, Limited, under any concessions or contracts relating to such means of communication. Also to construct electric lighting works, and to acquire, use, and provide steam, electrical, hydraulic or other power. Signatories (with 1 share each): C. L. Smiles, J. R. Yates, 15, Bedford Row; W. H. Rawle Judd, 33, Liverpool Street; N. G. Hill, 40, Counters Road, Kentish Town; T. J. Mason, 22, Lorrimore Road, S.E.; W. F. Symonds, Oak Lea, Lordship Lane; F. W. Binyon, Chichester Road, Croydon. The subscribers are to appoint the first directors. Qualification, £100 in shares or stock. Remuneration—chairman, £200 per annum; other directors, £150 per annum. Registered 14th inst. by Smiles, Ollard and Yates, 15, Bedford Row. Registered office, 66, Old Broad Street.

**Vaughan Sherrin Electrical Engineering Company, Limited.**—Capital £25,000, in £5 shares. Objects: To manufacture and supply electric motors, generators,

tricycles, bath-chairs, boats and machines, either wholly or partly propelled or worked by electricity upon any system whatever, and to carry on the business of electrical and mechanical engineers. Signatories (with 1 share each): E. H. Roberts, 85, Rushmore Road, Clapton; H. Floodgate, 123, Pall Mall; Henrietta Sherrin, 19, Duncan Terrace, N.; H. H. Paice, 81, Lydner Road, N.; J. H. Dempster, 59, Abbey Street, Bermondsey; T. J. Edwards, 18, Standard Street, Newington; Miss Ellen Mary Simmonds, 19, Duncan Terrace, N. Mr John Vaughan Sherrin is appointed managing director, at a salary of not less than £300 per annum. The minimum remuneration of the ordinary directors is £400 per annum. Registered 16th inst. by Lowless and Co., 26, Martin's Lane, E.C.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Thornebury Miner's Safety Lamp Company, Limited.**—An agreement of 30th ult., filed 31st ult., between James Thorne, of 85, Gracechurch Street, and the company, is supplemental to an agreement of 30th April and to an agreement of 20th May. The latter of these provided for the allotment of 15,000 fully paid shares of £1 each in part payment of the sum of £25,000 as purchase price for the British patent, No. 2779, of 1889. The said shares have been allotted, and sums of £2,500 and £1,960 have been paid in cash, and there now remains £5,540, and in settlement of this amount the present agreement provides for the allotment of fully paid shares.

**Dick, Kerr & Co., Limited** (engineers, electricians and contractors for railways, tramways, and other undertakings).—An agreement of 31st May, filed 20th June, provides for the purchase of the business carried on by Frederick Mannelle and John Kerr at 101, Leadenhall Street and at Kilmarnock, Ayrshire, under the style of Dick, Kerr & Co. The consideration is £115,000, payable £35,000 in cash and £80,000 in fully paid shares. An agreement of 6th June confirms the above.

**Allen, Everitt and Sons, Limited** (metal manufacturers, wire drawers, and electrical engineers).—An agreement of 5th June, filed on the 17th June, provides for the purchase by the company of the business carried on by Allen, Everitt and Sons at the Stephenson Works, Birmingham, and in London. The purchase consideration is £223,000, payable £132,000 in cash, £26,000 in £5 per cent. debenture stock, £33,000 in fully paid £6 per cent. cumulative preference shares, and £32,000 in ordinary shares, credited with £8 as paid up.

**Eastern and South African Telegraph Company, Limited.**—At an extraordinary general meeting of the shareholders in this company, held at Winchester House on the 17th ult., the following resolution was passed:—"That Article 100 of the company's articles of association be altered by striking out therefrom the word 'inclusive,' and inserting in lieu thereof the word 'exclusive.'" The resolution was confirmed on the 1st inst., and duly filed on the 7th inst. The article referred to the directors' remuneration of £1,200, inclusive of the amount paid to the managing directors, but which now stands exclusive of such amount.

The annual return of this company, made up to the 31st ult., was filed on the 13th inst. The nominal capital is £600,000 in £10 shares, the whole of which are taken up and are fully paid.

**Exeter Electric Light Company, Limited.**—The annual return of this company, made up to the 5th inst., was filed on the 11th inst. The nominal capital is £20,000, in £10 shares; 915 shares are taken up, and upon 780 of these the full amount has been called, and £2 per share has been called upon two

shares, the remaining 133 shares being considered fully paid up. The calls paid amount to £7,634, and unpaid to £186.

**Electric Date and Time Stamp Company, Limited.**—The annual return of this company, made up to the 30th ult., was filed on the 11th inst. The nominal capital is £121,000, divided into 100,000 ordinary and 21,000 deferred shares of £1 each. There are 6,893 ordinary and 21,000 deferred shares taken up, 25,500 been considered fully paid. Upon 2,393 ordinary shares the full amount has been called, the calls paid amounting to £1,824 5s., and unpaid to £568 15s.

**Column Printing Telegraph Syndicate, Limited.**—At an extraordinary general meeting of this company, held at 5, New Bridge Street, on the 30th June, it was resolved:—"That the capital of the syndicate be increased to £25,000 by the creation of 300 new shares of £50 each." The resolution was confirmed on the 16th ult., and was duly filed on the 8th inst.

The annual return of this company, made up to the 12th of August, was filed on the following day. The nominal capital is £25,000 in £50 shares; 171 shares are taken up, and of these 100 are considered as fully paid. Upon 71 shares £18 15s. per share has been called up and paid, the calls paid amounting to £1,331 5s.

**Mutual Telephone Company, Limited.**—At an extraordinary general meeting, held at the Memorial Hall, Albert Square, Manchester, on the 21st ult., the following special resolution was passed, viz.:—"That the articles of association of the company be altered in manner following: (a) In Article 99 the word 'ten' shall be substituted for the word 'six.' (b) The following article shall be substituted for Article 100, namely: 'The directors may, with the authority of the company in general meeting, take from the said reserve fund in any year such sum as the directors may think it desirable to apply towards payment of dividends on the shares, provided that in no case shall the dividends on the shares exceed 10 per cent. per annum on the amount paid up or credited as paid up thereon.' The original Article 99 relates to the payment of dividends not exceeding 6 per cent. per annum, and Article 100 authorises the directors to take from the reserve fund such sum as may be required to make up 6 per cent. per annum dividend. The above special resolution was confirmed on the 7th inst., and was duly filed on the 11th inst.

**Venezuela Telephone and Electrical Appliances Company, Limited.**—The statutory return of this company, made up to the 29th ult., was filed on the 15th inst. The nominal capital is £70,000, in £1 shares, the whole of which are taken up. 56,756 shares are considered as fully paid, and upon 13,244 shares 15s. per share has been called up. The calls paid amount to £9,544, and unpaid to £389. Registered offices: 37, Lombard Street.

**Institute of Medical Electricity, Limited.**—The office of this company, formerly at 24A, Regent Street, is now situate at 35, Fitzroy Square, W.

**Rastrick and Son, Limited** (chemists, opticians, and electricians).—The registered office of this company is situate at 7, King's Terrace, Southsea.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Petroleum Engine Company, Limited.

The report of the directors, for the year ending June 30th, 1890, states that:—

The progress of the company during the past twelve months has not in some respects been so rapid as the directors could have wished, but it is hardly necessary to point out that in developing an entirely new motive power, time is required to establish

sufficient confidence to secure orders freely from the general public.

The steady progress which has been made up to the present time is shown by the fact that the royalties received prior to June, 1888, amounted to £18, while the royalties received for the year ending June, 1889, amounted to £559, and the royalties received for the year ending June, 1890, amounted to £1,035.

Amongst orders recently received, many instances could be given where consulting engineers and others have been watching the working of the engine during the past 18 months before taking upon themselves the responsibility of recommending its adoption.

A considerable number of repetition orders have been received during the past 12 months, and an engine lately supplied represents the sixth order from the same purchaser.

The Priestman engine has recently been adopted by the Crown agents for the Colonies, the Norwegian and Egyptian Governments, and the Trinity House. The Northern Lighthouse Board, after making prolonged tests with three 5-horse-power engines supplied for a fog signal station, have given a further order for three engines of the same size for a second station.

The Royal Agricultural Society offered special prizes this year for light portable motors, arranged in two classes—firstly, for steam and hot air; and secondly, gas and oil engines. The first and only award in the second class was given for the Priestman engine, and the *Times* newspaper of June 23rd says:—"The first prize of £30 was awarded to Messrs. Priestman Brothers, Limited, of Holderness Foundry, Hull, for their well-known portable oil engine, to whom we believe the silver medal of the society has already been awarded. This engine is most economical in working, costing less in this respect than any other motor in either class."

Mr. Alderman Bailey, ex-President of the Manchester Association of Engineers, who read an interesting paper on the subject of "Canal Boat Propulsion," after tracing the history of steam propulsion from the first application of steam in 1799 down to the present time, adds:—"The Manchester Ship Canal Company, for the Bridgewater narrow canal, has recently purchased two Priestman's patent double-cylinder 10 horse-power vertical oil engines, with bevelled wheels, frictions, shafting, bearing, propeller shafts, stern tubes, and propellers. The engine was guaranteed to work with an expenditure of oil not exceeding 13½ pints per hour. On trial trips made, the expenditure was 10 pints per hour."

It is satisfactory to note many facts which indicate that the habitual distrust of new mechanical and scientific inventions is gradually yielding to the numerous demonstrations of the complete adaptability of the Priestman oil engine to the diverse purposes for which it has been brought into actual use, and a progressive increase of sales is confidently anticipated.

The amount of royalty paid by the licensees during the 12 months does not by any means represent the royalty on the whole of the engines sold up to the 30th of June last, as by the terms of the agreement, royalty is only payable to your company after the engine itself has been paid for.

The income and expenditure account shows a balance in favour of the company of £440 14s. 7d., which the directors recommend shall be carried forward to next year's account.

The retiring directors are Messrs. Henry Pawson and Ernest Moreton, who offer themselves for re-election. The secretary has received a notification from Mr. Septimus Gibbon, of 36, Finsbury Pavement, London, E.C., that he intends to offer himself as a director.

### General Electric Company.

The statutory general meeting of the shareholders of the General Electric Company, Limited, took place on Tuesday at the offices, 71, Queen Victoria Street.

Mr. Gustav Binswanger (the chairman of the company), who presided, stated that the business of the company was divided into three departments—electric lighting, electric bells, and the works at Manchester. The result of the trading was that they were able to recommend a dividend of 15 per cent. on the preference shares, and of 7½ per cent. on the ordinary shares, carrying, at the same time, a sum of £637 to reserve. This result must be considered extremely satisfactory, inasmuch as the earning power of the company upon the actual capital invested was more than 25 per cent. per annum. The business was continuing to show a very substantial increase, and as the winter was the best time for a business of this description, they had every prospect of being able to double the returns. The chairman concluded by moving the adoption of the report and accounts.

Mr. Myerstein seconded the resolution, which was unanimously agreed to, and the dividends as recommended were also declared.

Mr. T. J. Seel was re-elected auditor of the company.

Mr. Hess proposed, and Mr. Goldschmidt seconded, a vote of thanks to the chairman and directors, and the meeting separated.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 16th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,718.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 15).	Closing Quotation. (August 21.)	Business done during week ending August 21, 1890.	
					Highest.	Lowest.
£						
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	97 — 100		
1,549,160	Anglo-American Telegraph, Limited ... ..	Stock	49½ — 50½	50½ — 51½	51	49½
2,725,420	Do. do. 6 p. c. Preferred ... ..	Stock	85 — 86	87 — 88	88	86½
2,725,420	Do. do. Deferred ... ..	Stock	13½ — 14½	14½ — 15½	15½	14
130,000	Brazilian Submarine Telegraph, Limited ... ..	10	11½ — 12½	11½ — 12½	12½	11½
99,000	Do. do. 5 p. c. Bonds ... ..	100	100 — 102	100 — 102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416...	3	1½ — 2	1½ — 2		
63,416	Do. do. Preference, Nos. 1 to 63,416 ... ..	2	1½ — 2	1½ — 2		
\$7,216,000	Commercial Cable, Capital Stock ... ..	\$100	103 — 105	103 — 105	105	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	5½ — 5½	5½ — 5½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,900	Cuba Telegraph, Limited ... ..	10	12½ — 13½xd	12½ — 13 xd	12½	
6,000	Do. do. 10 p. c. Preference ... ..	10	16½ — 17½xd	16½ — 17½xd		
12,931	Direct Spanish Telegraph, Limited ... .. (£4 only paid)	5	3½ — 4	3½ — 4	3½	
6,090	Do. do. 10 p. c. Preference ... ..	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877 ... ..	20	10½ — 10½	10½ — 10½	10½	10½
400,900	Eastern Telegraph, Limited, Nos. 1 to 400,000 ... ..	10	13½ — 14½	13½ — 14½	14½	13½
70,000	Do. 6 p. c. Preference ... ..	10	15 — 15½	15 — 15½	15	
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	107½	
1,290,000	Do. 4 p. c. Mortgage Debenture Stock ... ..	Stock	106 — 109	106 — 109	108	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½	14 — 14½	14½	14½
320,000	Do. 6 p. c. Debentures, repay. February, 1891 ... ..	100	100 — 102	100 — 102	100½	
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 — 106	103 — 106	104½	
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings ...	100	103 — 106	103 — 106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	100 — 103	100 — 103	102	101
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000 ... ..	5	4½ — 5½	4½ — 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5½ — 5½	6 — 6½	6½	5½
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ... (£3 only paid)	5	2 — 2½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited ... ..	10	8½ — 9½	8½ — 9½	9½	8½
180,042	Do. do. 6 p. c. Preference ... ..	10	14½ — 15½	14½ — 15½	14½	14½
150,000	Great Northern Tel. Company of Copenhagen ... ..	10	15½ — 16	15½ — 16	15½	15½
40,900	Do. do. 5 p. c. Debs. (issue of 1881) ... ..	100	100 — 103	100 — 103		
250,000	Do. do. do. (issue of 1883) ... ..	100	106 — 109	106 — 109	106	
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	12 — 13	12 — 13		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000 ...	10	11½ — 12½	11½ — 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18½ — 19½	18½ — 19½	18½	18½
200,000	Do. do. 4½ p. c. Deb., 1896... ..	100	102 — 104	102 — 104	18½	
17,000	Indo-European Telegraph, Limited... ..	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited ... ..	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures ... ..	100	107 — 110	107 — 110	109	
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 ...	10	4 — 4½	4 — 4½	4½	4½
436,700	National Telephone, Limited, Nos. 1 to 436,700 ... ..	5	4½ — 5½	4½ — 5	5½	4½
15,000	Do. 6 p. c. Cum. 1st Preference ... ..	10	12½ — 12½	12 — 12½	12½	
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	4 — 4	4 — 4		
9,000	Reuter's, Limited ... ..	8	7½ — 8½	7½ — 8½		
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	4 — 4	4 — 4		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3		
3,381	Submarine Cables Trust ... ..	Cert.	113 — 117	113 — 117		
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5 — 5½	5 — 5½	5½	5
37,350	Telegraph Construction and Maintenance, Limited ... ..	12	42 — 44	42 — 44	43½	42
150,000	Do. do. do. 5 p. c. Bonds, red. 1894 ... ..	100	100 — 102	100 — 102		
55,000	United River Plate Telephone, Limited ... ..	5	3½ — 4½	3½ — 4½	3½	
146,000	Do. do. 5 p. c. Debenture Stock... ..	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ... ..	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109 ... ..	10	9 — 10	9 — 10		
300,000	Do. do. do. 5 p. c. Debentures ... ..	100	100 — 103	100 — 103		
30,000	West Coast of America Telegraph, Limited ... ..	10	4 — 5	3 — 5	4½	3½
150,000	Do. do. do. 8 p. c. Debs, repay. 1902 ... ..	100	106 — 110	106 — 110	106	
64,572	Western and Brazilian Telegraph, Limited ... ..	15	10½ — 11½	11½ — 11½	11½	11½
26,986	Do. do. do. 5 p. c. Cum. Preferred ... ..	7½	6½ — 7	6½ — 7½	6½	6½
26,986	Do. do. do. 5 p. c. Deferred ... ..	7½	4 — 4½	4½ — 5½	5½	4½
200,000	Do. do. do. 6 p. c. Debentures "A," 1910... ..	100	103 — 106	103 — 106		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 — 104	101 — 104		
88,321	West India and Panama Telegraph, Limited ... ..	10	2½ — 3	2½ — 3	2½	2½
34,563	Do. do. do. 6 p. c. 1st Preference ... ..	10	11½ — 11½	11½ — 11½	11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference ... ..	10	13 — 14	13 — 14		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
179,300	Do. do. do. 6 p. c. Sterling Bonds ... ..	100	99 — 101	99 — 101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 1½	1½ — 1½		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Electric Construction Corporation (£10 paid), 7½—8½  
 Elmore Copper Depositing Priorities, 7—7½.—Elmore Wire, ½ dis—par.—House-to-House Company (£5 paid), 5—5½.—Inter-  
 national Okonite, Ordinary of £10 (£4 paid), 3½—4½.—London Electric Supply Corporation, Ordinary (£5 paid), 1½—2½.—  
 Manchester Edison and Swan Company, £9 (£1 paid), 11/-—13/-.

## ELECTRICALLY HEATED TREVELYAN INSTRUMENTS THAT CAN BE USED AS MICROPHONES.

By A. M. TANNER.

IN my researches concerning the uses of carbon for electrical purposes I was at once struck with the great similarity certain types of Trevelyan instruments bear to the microphone, or that form of telephonic instrument, in which loose contacts of solid or hard carbon are employed for regulating the tension of the current in a closed electric circuit.

In Poggendorff's *Annalen der Physik und Chemie*, for Vol. 104, page 413, appears an article by Paalzow concerning some phenomena of motion in the closed circuit of a galvanic battery. It is here stated "that when a thin sheet of platinum is placed upon a copper plate that is connected with one pole of a battery of four Bunsen elements and a piece of carbon in the form of a half ring is placed upon the sheet of platinum, a cavity in the free end of the carbon receiving a drop of mercury, then a regular rocking motion of the carbon takes place when a platinum wire led into the mercury is connected with the other pole of the battery. The arrangement of parts for carrying out the experiment is illustrated by fig. 1, in which *a* is the copper plate, *b* the sheet of platinum, and *c* the carbon.

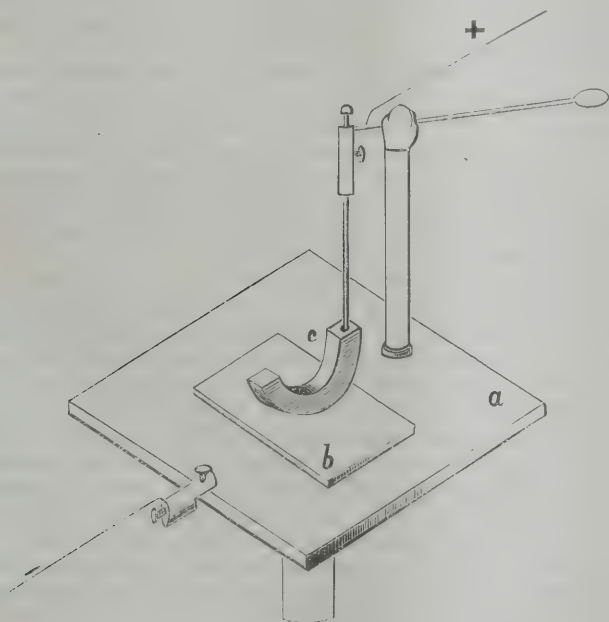


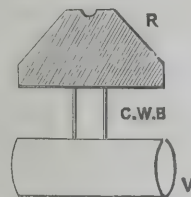
FIG. 1.

From experiments to determine the most favourable presentation of this phenomenon it was at once ascertained that sheet platinum such as is ordinarily used in Grove batteries, was best adapted for the purpose, and that very thin sheet brass and copper caused the phenomenon to appear in a weaker form, while the thinnest plates of other metals did not show it at all. When the metals were soldered to a copper plate of considerable thickness, then in the case of platinum the vibratory motion of the rocker was observed after the latter had remained a long time upon the platinum and sparks had passed. The rocker must be made of good conductivity such as is used in Bunsen elements and for the production of the electric light; wood carbon was not moved at all. Simultaneously with the movement of the rocker the passage of sparks between the carbon and platinum plate was observed, and when the motion of the rocker grew so violent that the platinum wire passed out of contact with the mercury, sparks were also observed between the platinum wire and mercury. Before the rocking took place, an elevation of the carbon always occurred, as if it were attracted by the platinum wire, and frequently there was only an

elevation of the carbon and no regular movement at all."

After the foregoing description, the experimenter discusses the probable cause of the rocking motion of the carbon, and says it cannot be attributed to repellant action; experiments disproved this theory, since the rocking movement did not take place with all metals. Then it is stated that it might also be due to the passage of the spark between the carbon and platinum which caused a hurling of the carbon particles with such a force as to produce the working movement; this theory was, however, also disproved by experiments.

Then Paalzow continues and says: "It can be shown, however, that the heat which is developed at the contact point by the passage of the spark, produces a change of form of the platinum plate, which necessarily must cause a movement of the carbon. When the rocker, or even a flat surfaced piece of carbon was placed on the platinum, then a raising of the edges of the platinum was observed during the passage of the spark." Paalzow then arrives at the conclusion "that at the point where the platinum is nearest the carbon, a spark passes across, and at the same time an unequal heating and change of form of the platinum takes place, so that the carbon is thrown out of balance, whereupon the passage of the spark is transferred to some other point, followed by another movement of the platinum and carbon. If the platinum surface is even, then the passage of the spark will take place where the carbon presses the platinum with the most force, so that upon the change of position of the carbon, the passage of the spark must again take place where the carbon touches the platinum. In Poggendorff's *Annalen*, vol. 105, page 620, Rollman calls attention to the fact, that as early as 1850, he described a Trevelyan instrument, moved by the galvanic current, in the *Jahresberichte des naturwissenschaftlichen Vereins in Halle*, page 189. This journal, consulted by me, states that it is known that the Trevelyan instrument is operated by the heating of the "rocker" or the "bearer." If both are allowed to remain cold, the sound can also be produced by passing a galvanic current through the in-



R, rocker; C.W.B., copper wire bearers; V, vice.

FIG. 2.

strument. The explanation is easy. The current will not produce a perceptible raising of the temperature of the massive rocker or bearer, but will cause a heating at the two points where they touch each other. What follows can be easily understood. I obtained sounds with bearers and rockers made of copper, and with a brass rocker and iron bearer connected with two Bunsen or Grove elements. The idea of operating the instrument in this manner is due to Prof. Hankel." In the article in Poggendorff's *Annalen*, Rollman says that all materials that are good conductors of electricity may serve for the carrier and rocker, provided the proper shape is given them at the contact points. Then he says that he experimented with rockers of brass, steel and gas carbon, and maintained the same in a state of permanent vibration upon bearers of gold, platinum, silver, copper, brass, nickel, German silver, iron, steel, zinc, cadmium, tin, lead, antimony, wismuth, aluminium and gas carbon.

Referring to the carbon rocker he says it was a roughly cut piece of gas carbon of a prismatic form (6 inches long, 1 inch wide and 1½ inches thick), provided with a handle. The bearers were by reason of the form of the rocker worked out into points and stretched in a screw clamp as was already done by Tyndall and Seebeck.

In order that this paragraph of Rollman's description

can be easily understood, I have consulted the published experiments of Tyndall and Seebeck, concerning vibrations and tones produced by the contact of bodies having different temperatures. It may be well to state here that neither proposed the use of carbon rockers and bearers. Tyndall's experiments are found described in the London, Edinburgh and Dublin Philosophical Magazine for 1854, vol. 8, page 1-12. Among other forms of rockers he describes one of a prismatic form, supported by its flat side on two pointed copper wires stretched in a vice (fig. 2).

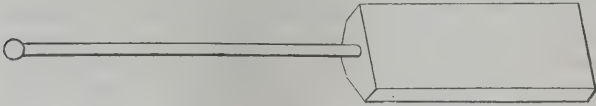


FIG. 3.

Tyndall also shows this form of rocker provided with a handle (fig. 3).

Seebeck's experiments are described and illustrated in Poggendorff's Annalen, vol. 51, page 1. The following are some of the forms of bearers and rockers used by him (fig. 4).

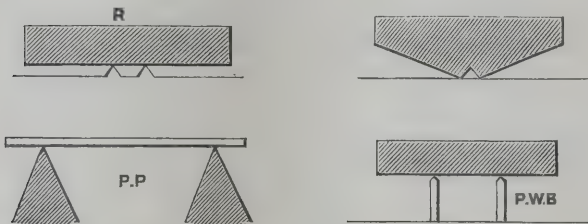


FIG. 4.

R, rocker; P, P, pyramidal points; P W, B, pointed wire bearer.

It will thus be readily seen what Rollman means when he speaks of "carbon bearer points stretched in a screw clamp and supporting a carbon rocker of prismatic form." Continuing Rollman's description of his instrument, he says "that the handle of the rocker rested upon a second suitable support, and to its end was soldered a wire which dipped into mercury, so that the current could easily be led through the carrier and rocker." As the source of electricity, he always used a single zinc-iron element. Frequently the vibrations obtained were slow, so that they could be easily counted; at other times they followed each other so rapidly as to run together into more or less high tones. The rapidity of the vibrations is chiefly due, as appears to me, to the distance of the bearer points, the weight, the shape, and the position of the centre of gravity of the rocker, and, finally, to the heating and expansion of the contact surfaces. No sparks appear at the two contact surfaces between the bearer and rocker, as the *contact is never broken there*. A slight spark is, of course, imperceptible to the eye, but its absence was ascertained by the polished brass rocker, which never showed the slightest trace of oxidation. The same thing was also proved by the galvanometer; when a portion of the current was by a branch wire led into the same, and the needle hardly went back, when the rocker, which had previously rested quiet, was lightly struck. The slight weakening of the current shown by the galvanometer is explained by the increase of resistance, because during vibration the rocker rests generally only upon one point and only rests momentarily upon both points when it falls upon the other side.

In view of the importance of this last paragraph, it disclosing the variable contact principle of the microphone, it is best to give it also in the original, viz.:—*Die durch diesen Rückgang (of galvanometer) angezeigte geringe Schwächung des Stromes erklärt sich aber durch die Vermehrung des Leitungswiderstandes da berin Tönen der Wieger meist auf einer*

Spitze schwebt und nur wenn er auf die andere Seite fällt momentan auf beiden Spitzen ruht.

Rollman in commenting upon Paalzow's statement concerning the operation of his instrument, says that if sparks were shown between the carrier and rocker, it must be attributed to the heavier current (Paalzow used 4 platinum elements), and, on the other hand, to the lighter piece of carbon, although it is not probable that *even in his case the contact was ever completely broken*.

It is not contended by the writer that the foregoing references disclose the principle of varying the strength of a battery current in unison with the rise and fall of vocal utterances or sound waves; but it is unquestionably true, that Rollman constructed an instrument for giving out sound, in which the variation of the electrical resistance was attained by two loose contacts of solid carbon under different degrees of contact pressure, effected by the passage of the current itself, and not by sound waves. In connection with the principle set forth by Rollman, that two loose carbon contacts will by change of position vary or modify the current in a closed electric circuit, it is well to refer to Stroh's experiments with carbon contacts in microphones, described in the London *Electrician* for April 28th, 1883. It is here stated that "it also appears evident that a current crossing a microphonic contact, has a strong tendency to cause vibratory disturbances, and it seems, therefore, reasonable to suppose that during microphonic action, even when all is in good adjustment, the sound waves which are transmitted are accompanied by other vibrations which are due to the passage of the current itself."

As the Trevelyan instruments of Paalzow and Rollman have a loose contact piece of carbon bearing lightly upon another contact piece of platinum or carbon and are to be used in a close galvanic circuit, it is self-evident from the close resemblance these instruments bear to microphones, that they can be used for telephonic transmission when combined with a proper receiving instrument.

The "half ring-shaped carbon contact" found in Paalzow's instrument, can be made to operate in the same manner as the carbon spheres and loose gravitating cylinders used in certain types of microphones or carbon transmitters, and the very instrument described and illustrated by Paalzow, will undoubtedly serve as a microphone transmitter, when used in connection with a battery current, not too powerful to cause sparking. As to Rollman's instrument, in which a carbon prism is supported upon carbon rods or bearers, it will be seen that it strongly resembles the instruments used by Professor Hughes in carrying out his experiments "on the action of sonorous vibrations in carrying the force of an electric current," first described in the *Proceedings of the Royal Society* for 1878, page 362.

Rollman's discovery can well be defined as the action of a vibrating solid carbon body for varying the force of an electric current in a closed circuit.

## THE INFLUENCE OF ELECTRIC RAILROADS UPON TRANSATLANTIC TELEGRAPHY.\*

By CHARLES CUTTRISS, Electrician Commercial Cable Company.

IT would hardly seem possible that the two above-mentioned industries could in any way clash, but the following account of trouble traced directly to an electric railroad will show that they do so, and that ultimately difficulties may arise which will have a serious effect upon transatlantic telegraphy, and unless some remedy is found, we may possibly have to resort to a less speedy communication between the two countries.

For many years it was the practice of cable companies to pick out some quiet, secluded spot in which to land their cables and to use land lines for the remain-

\* *Electrical Engineer*, New York.

ing distance to the nearest important city, using it as a radiating centre. This plan necessitated one transmission or repetition more than was actually necessary, and also caused a loss of time which it was very desirable to save. The Commercial Cable Company was the first to make an innovation, and in order to give quicker communication decided to land their sea cable at Coney Island, and continue it with an underground cable through Ocean Avenue and Brooklyn into the heart of this city, thereby practically making the terminus of their cable in Wall Street. Past experience had shown the advisability of using a return earth circuit as far as the sea, so the underground cable was constructed with four cores laid up in the usual manner and only separated from one another by about  $\frac{1}{32}$  of an inch.

The cable proper is connected to one of the cores by a permanent sea joint, and the diametrically opposite core, which is used as the return earth to the sea, is soldered directly to the sheathing wires of the sea cable, and the other two cores are kept spare in case of trouble.

This plan has given the utmost satisfaction until within the last few months, when we began to experience some trouble from occasional kicks on our receiving instrument; sometimes they would be so strong as to obliterate a signal. As these kicks are nothing unusual during the summer months, owing to thunderstorms and other atmospheric disturbances, they were for some weeks attributed to such causes.

During this period it was also noticed, when testing the cable, that the mirror seemed to be very unsteady, and had erratic movements, which denoted by their abruptness that the cause of disturbance was near this end of the cable, and was such as might be produced by a small fault.

To satisfy myself on this point I had the cores cut at the cable house on Coney Island, and while I was testing the undergrounds, the electrician at Canso, Nova Scotia (the distant end of the cable), was also testing the sea cable. The results showed that both the undergrounds and the cable were in perfect condition, but it was observed on the undergrounds that there was some disturbing cause in their neighbourhood; as, after perfectly discharging the cores, they would in a few seconds become quite heavily charged, always with the same potential; this phenomenon, of course, was only remarkable in the degree of charge. So far, we had arrived at only negative results, as the kicks, &c., were still present on joining up the working instrument.

About this time it came to my knowledge that there had recently been an electric railroad established, running from Prospect Park, Brooklyn, to Coney Island by way of the old Coney Island horse car road. Immediately it occurred to me that here possibly was the source of trouble. It must be remembered that ocean cables are operated by a recording instrument, that is so sensitive that a current of  $\frac{1}{1000}$ th of a milliampère will produce a distinct working signal; hence it is quite conceivable that, although the electric road does not in any part of its route approach our underground cables nearer than about *half a mile*, disturbances might be produced by the ever-varying power used in starting and running the cars. To prove the correctness of the assumption, I connected a telephone between the cable and its return earth and could distinctly hear the starting and stopping of the cars. The telephone was then connected to the cable and a local earth in the city, namely, the water pipes; the sounds then became so much louder that they could be heard with the telephone a short distance from the car. The testing galvanometer, a Thomson astatic, of course could not pick up such rapid vibrations, but it shows deflections and kicks to such a degree that we have sometimes been obliged to give up testing and try at a more favourable time, such as 1 or 2 a.m., when the cars have stopped for the night. This naturally is somewhat inconvenient.

Now comes the question, if the disturbance is so severe with the railroad at a distance of half a mile or 2,640 feet, what would be the effect on the company's

property if at some time an electric road should be projected down Ocean Avenue where the rails would in all probability be within 4 or 5 feet of the cable for a minimum distance of  $5\frac{1}{2}$  miles? With telephones and ordinary telegraph instruments the use of a metallic circuit is a good protection, but in the present case it is proved that a metallic circuit through the disturbed district does not grant immunity from serious disturbance.

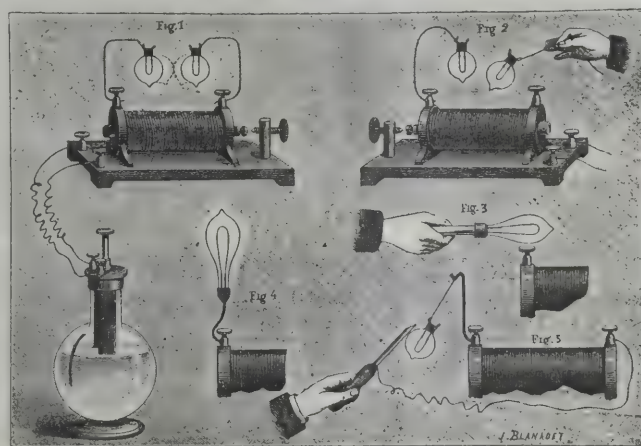
One point is still to be determined in regard to this phenomenon, namely, to ascertain for a certainty whether the effects produced are to be attributed to conduction through the earth and water to our armouring, or if it is an inductive effect. The fact, nevertheless, remains that if electric roads should be greatly augmented in our immediate vicinity the disturbances on our lines will be seriously increased, and at present it is difficult to conceive of any remedy other than the adoption by the roads of a double trolley system.

The tests show our undergrounds to have a dielectric resistance of about 350 megohms per mile, so the idea of any leakage cannot be entertained.

### EXPERIMENTS WITH ELECTRICITY.

WE, says *La Nature*, have received from a subscriber in Mexico a highly interesting description of some experiments with the Rhumkorff coil and incandescent lamps. These have been repeated by us at the laboratory attached to the Halles electric station, and we are now in a position to lay them before our readers, together with some hints of a practical nature.

By attaching two curved wires, each supporting an incandescent lamp, to the terminals of the secondary circuit of a Rhumkorff coil (fig. 1), we observe an approximation of the two lamps at the moment of the current's passing. The phenomena is particularly marked at a distance between the lamps of 3 to 5



millimetres. Care must be taken that the supports shall be very flexible, and for this purpose a copper wire, 1 millimetre in diameter, and insulated with gutta-percha, will be found perfectly suitable. It is likewise important to avoid direct sparks between the lamp sockets. It is necessary to the attraction that there should be a discharge traversing the lamps and compelling the approximation. By suspending one of the lamps (fig. 2) and holding the other in the hand, the attraction between them will be the same. A lamp placed upon a terminal of the secondary circuit of a Rhumkorff coil (fig. 3) will become luminous, and it will be only necessary to approximate a lamp to a terminal to obtain gleams of equal brilliancy (fig. 4); suspend a lamp by a flexible wire at one terminal (fig. 5) and approximate to it any point in connection with the other terminal, and an attracted and sustained gleam will be observable. These experiments may be varied at will; those above-described are intended as examples merely.

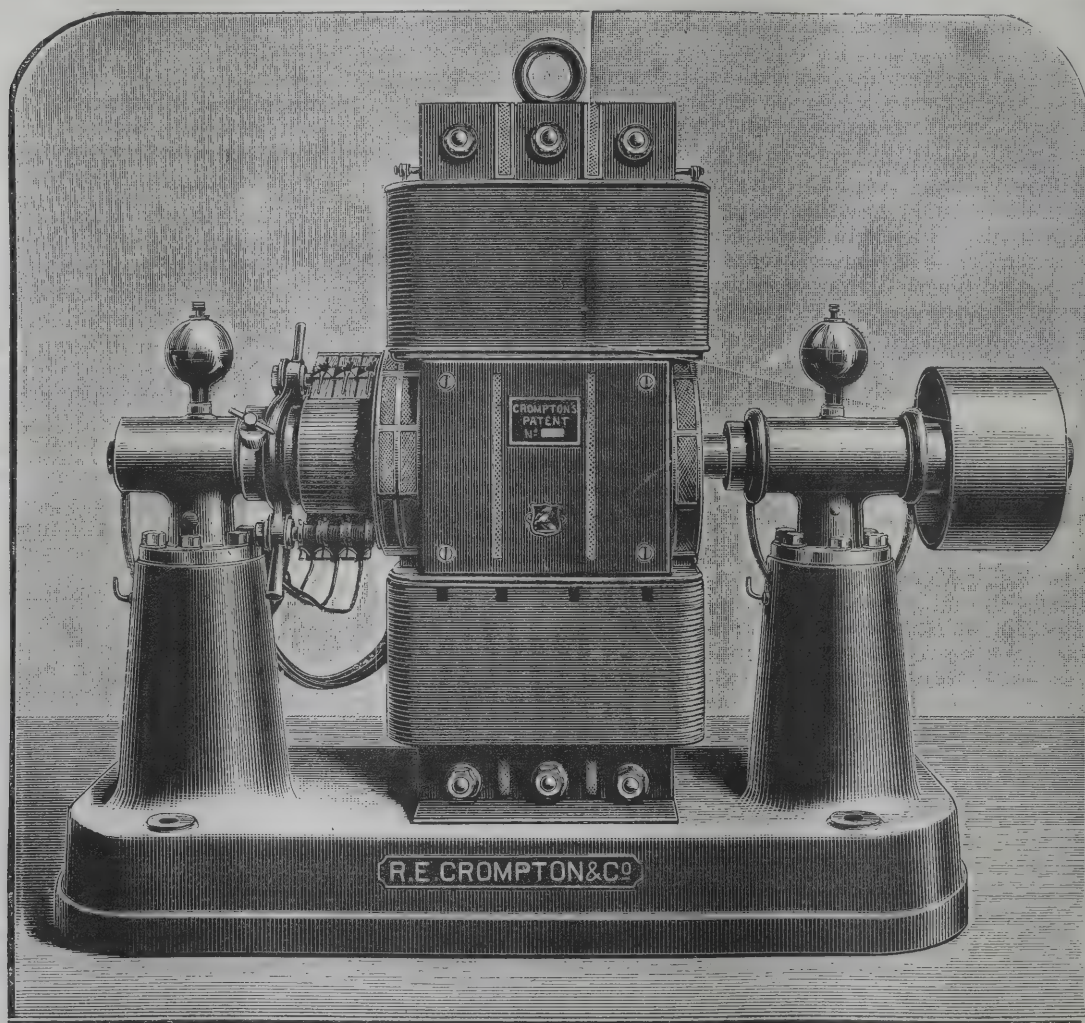
**THE SOUTHEND PIER ELECTRIC TRAMWAY.**

ELECTRICAL traction in this country is making slow but sure progress. Although engineers on this side have been confined to the development of underground systems of conductors, or to the use of accumulators, in neither of the latter two cases has sufficient success been hitherto attained in England to sufficiently attract the public attention to the manifold advantages which any system of electrical haulage presents.

It is therefore with pleasure that we notice an extremely successful addition to the few electrical tramways now being worked in this country, and to the opening of which we have already briefly alluded. The Southend Local Board, which is a very enterprising public body, and has introduced a large number of local improvements with a view of further popularising the

and build the car, motor, &c. By good management and a willing staff, they were fortunate enough to succeed in carrying out their contract one day within the time, and extreme credit is due to everyone concerned, particularly to Mr. Chamen, the chief of their outdoor staff, and to Mr. Scott Moncrieff, who is resident at Southend, for the extraordinary rapidity with which the work has been carried out, without a hitch or alteration in the original design.

The generating plant consists of a horizontal compound engine by Davey Paxman, supplied with steam by a boiler of locomotive type. Both are extremely favourable examples of the highly economical and extremely efficient class of steam engine that this well-known firm is now turning out. This engine drives a Crompton compound dynamo of their standard type, having an output of 150 ampères by 200 volts at the terminals, and having a commercial efficiency exceed-



CROMPTON DYNAMO FOR GENERATING CURRENT.

already rapidly increasing town of Southend, has recently constructed a new iron pier, costing about £80,000, to replace the old wooden one, which was itself one of the most remarkable constructions of the kind in the country, being a mile and a quarter long, and fitted with a horse tramway. The board decided to replace horse traction on the new pier by an electric tramway, and after specifications had been issued, Messrs. Crompton secured the contract in public competition. One feature of this contract was the short period in which it had to be carried out, namely, that a length of three-quarters of a mile, with an electrical tramcar, and all the plant, as well as the lighting of the pier, should be completely set to work on the day previous to the August bank holiday, in order that the traffic might be secured for the new tramway.

This only gave the contractors six weeks in which to lay the track and supply all the generating machinery

ing 90 per cent. The electrical energy is conducted from the engine room by insulated cables carried along the pier to the commencement of the car track, and from thence to the end of the pier. Messrs. Crompton determined to use their stock pattern flat strip copper conductor that they have been using for the past four years in the streets of London, the whole of the supports, insulators, and straining gear being taken from the stock, and identical in all respects with those they have used in upwards of 30 miles of streets in Belgravia, Kensington, and Notting Hill. The strip used in this instance is an inch wide by .134 inch thick, and is supported at intervals of 15 yards by vertical insulators, and strained in lengths of 85 yards by straining gear having volute springs, to compensate for expansion due to differences of temperature, the insulators in both cases being the stock pattern used for street mains.

The track consists of a pair of Vignoles rails 3-inch

by 6-inch gauge, the strip conductor being laid about one foot distant from one of the rails, and one inch below the level of the rail tops. The rails themselves are used for the return. The car was built for Messrs. Crompton's order by Messrs. Kerr Stuart, and the motor is a stock pattern Crompton dynamo, the speed being reduced 3 to 1 by simple spur gearing. The motor is fixed below the bottom of the car, and access can be given to it either by bringing the car over the pit or by lifting a trap in the flooring. The car is driven from either end, and the means of regulation are extremely simple. A pair of handles, one for reversing and one for starting, with the ordinary brake wheel in front of the driver, being all that is required.

The maximum speed of the car is 20 miles an hour, but in ordinary running the speed is kept down to about 12 to 14 miles an hour, so that the journey along the pier, which used to occupy previously about 15 minutes, is now performed in three to four minutes. The contact apparatus for taking the current through the strip consists of rubbing shoes, especially designed for this purpose by Mr. Chamen, and which appears to act very well, and without apparently causing any wear to the surface of the copper strip.

An official trial was made by Dr. Hopkinson, consulting engineer to the Local Board, on the 30th of July. He expressed himself completely satisfied with the workman-like manner and extreme celerity in which

## PARLIAMENTARY NOTES.

### TELEGRAPH CLERKS.

IN the House of Commons last Friday night, in answer to Mr. MacNeill,

Sir H. MAXWELL said: Mr. Quin, lately employed as a telegraph clerk at the central office, was dismissed for using the telegraph wire for private purposes, to the hindrance of public messages. Neither was the object with which he used the wires calculated to bespeak a lenient view of his conduct. Having formed one of a deputation to his controller, which pledged itself to a particular line of action, he had no sooner left the room than he proceeded to the telegraph wires and advocated another. Thus persons at a distance were stirred up by him to adopt the very course which the deputation, of which he was a member, had just assured the Department would not be adopted. For this act of duplicity, added to his infraction of a rule to which the Department attaches the highest importance, that the public wires shall not be used for private purposes, there was, in the Postmaster-General's judgment, only one suitable punishment, and that was dismissal. Mr. Quin's conduct inside the office had hitherto been good. There are many instances of clerks and others being dismissed for a first offence.



CAR.



END VIEW OF CAR  $\frac{1}{2}$  MILE UP PIER.

the work had been carried out, and the members of the Local Board, and the townspeople generally, have over and over again expressed their extreme satisfaction with the unexpectedly rapid completion of the work, and its great success. The day following the official trial the car was handed over to the Local Board for regular running, and has been running ever since without breakage or interruption of any kind. On Bank Holiday the car was overloaded every journey, and the takings amounted to upwards of £40, and ever since that day the takings have been heavy.

It is evident from this that the Southend authorities have made a good investment of the local funds in introducing this electrical tramway. The horsepower absorbed in driving a loaded car at full speed appears to be considerably below what Messrs. Crompton estimated it would be.

As soon as the pressure of public traffic of this season is over, Messrs. Crompton hope to be able to make a set of experiments to show what is the real tractive force required on this class of electrical railway, and intend to make these results public.

**The Electric Light in Paris.**—The right side of the Rue Auber, from the Rue Scribe to the Boulevard Haussmann, is now lighted by electricity. The arc lamps have been placed in the old gas lamps in the same way as at the Palais Royal.

### LIGHTING OF THE NATURAL HISTORY MUSEUM.

On the report of the votes passed in Committee of Supply,

Sir G. CAMPBELL, on the vote for the British Museum, asked whether arrangements could not be made for the lighting of the Natural History Museum, so that it could be used in the evening.

Mr. JACKSON said that, as the introduction of the electric light was a matter of experiment, it had been thought advisable to begin with the British Museum, because it was nearer to the masses of the people, and was more easily reached by them than was the Natural History Museum. The same pressure had not as yet been put upon the trustees to light the Natural History Museum, but experiments would be made with a view to the illumination of the building, should it ultimately be determined upon.

### SUBSIDIES TO TELEGRAPH COMPANIES.

On the report of the vote for subsidies to telegraph companies,

Dr. CAMERON moved the reduction of the vote by £6,075, being the amount of the subsidy to the Halifax and Bermuda Telegraph Company. He remarked that the circumstances attending the laying of this cable bore a most suspicious resemblance to an unbusiness-like job. The telegraph line from Halifax to Bermuda was one chiefly of strategic importance. In 1886

tenders were invited, and the lowest was that of the International Cable Company, which offered to do the work for a subsidy of £8,000 a year for 20 years. That was considered excessive, and in 1888 fresh tenders were invited and three were sent in, the same company being again lowest, with an offer to do it for a subsidy of £6,923 a year for 20 years. That offer was accepted, but subsequently the company was allowed to withdraw it on account of a rise in the material, presumably owing to the corner in copper. Tenders were again invited, and the International Cable Company was again the lowest, and was accepted at a subsidy of £8,100 for 20 years, but before the contract had been ratified the price of copper had collapsed, and, in addition, it must be remembered that a lower tender had been refused in 1886, on the ground that it was excessive. Again, the condition that £100,000 should be subscribed and fully paid up had not been insisted upon, although it was in the Treasury minute.

The Halifax and Bermuda Telegraph Company had its articles of association subscribed by one merchant, one accountant, one agent, and four clerks. The nominal capital amounted to £50,000, but according to information which came to Somerset House, only £35 had been subscribed by the gentlemen named in the articles. He would like to ask the right hon. gentleman what amount of subscribed capital this company had. The prospectus of the company involved statements which might probably prove to be extremely misleading about a subsidy from Her Majesty's Government. In his opinion, the Government ought to have warned the public against the statements contained in the prospectus. The company having been inaugurated, was, to a certain extent, connected with Her Majesty's Government, and they were responsible for it, because, under the contract, they nominated one member of the board, and consequently had a right to all the information about the company. He asked the secretary to the Treasury to state what was the amount of capital subscribed to this company on the 12th of April; what was the date on which he agreed formally to transfer the contract to them, and what amount of capital was subscribed at that date, independently of the debentures on which they got the country to subscribe money on grossly false pretences. He had brought this matter forward for two reasons. In the first place, it involved a gross infraction of the control of that House over contracts submitted to it for ratification; secondly, because of the peculiarities of the whole transaction from beginning to end.

Mr. JACKSON observed that he had already given a full explanation of the facts of the case, and went on to say that many questions had been asked which he was, of course, unable to answer. He must decline altogether, on the part of the Government, to accept responsibility for any statements which might be published in a prospectus. The whole question lay in a nutshell. The Government had taken a new departure with the object of securing the laying of the cable. The security was provided, the capital was subscribed, and the cable was to-day in working order. He thought the Treasury were to be congratulated on the economical manner in which they had carried out the undertaking.

Dr. CAMERON insisted upon a division, when 37 voted for the reduction of the vote and 23 against it.

The vote was then agreed to.

#### TELEGRAPHISTS.

In the House of Commons on Saturday, in answer to Mr. P. O'Brien, Sir H. MAXWELL said:—The scale introduced on July 11th last fixed the wages of second-class telegraphists at 12s. a week for the first year, at 14s. a week for the second year, and 18s. a week for the third year, thereafter rising by 2s. annually to 40s. a week. This scale is on the whole better, far better, than the one it superseded. In connection with the old scale, however, there was an arrangement under which a learner, if fully qualified, could receive 16s. on appointment, and it is being considered whether a similar advantage should not be given to those learners whose

employment began before the new scale was introduced.

#### TELEGRAPH RATES TO AUSTRALIA.

Mr. HENNIKER HEATON asked the Chancellor of the Exchequer whether he was aware that the Australian Governments had contributed a sum of £32,000 a year for the past eleven years to the Eastern Telegraph Company for maintaining and cheapening telegraph communication between Australia and Europe; whether the British Government contributed any portion of the subsidy; whether an application was made this year by the Agents-General of the New South Wales, the Victorian, and the South Australian Governments to the British Government to join in a guarantee against loss, on condition that the telegraph companies reduced the rates to and from Australia from 9s. 4d. to 4s. per word for ordinary messages, and from 7s. 5d. to 2s. 6d. per word for Government messages, and what answer, if any, was given to the Australian Governments.

THE CHANCELLOR OF THE EXCHEQUER: I understand that the subsidy in question was granted mainly with a view to the duplication of the cables between Java and Australia. The British Government did not contribute to the subsidy. An application to the effect indicated in the third paragraph of the hon. member's question was made, but Her Majesty's Government was unable to accede to it.

#### NEW PATENTS—1890.

12171. "Improvements in electric motor mechanism." S. E. MOWER. Dated August 5. (Complete.)
- 12221 "An improved apparatus for the measurement of electrical energy." H. H. LAKE. (Communicated by E. Weston, United States.) Dated August 5. (Complete.)
12228. "Improvements in commutators for dynamo-electric machines." J. W. EASTON. Dated August 5. (Complete.)
12231. "Commutators for electrical machines." W. W. VAIL. Dated August 5. (Complete.)
12244. "Improvements in sockets for electric lamps." A. V. NEWTON. (Communicated by A. Swan, United States.) Dated August 5.
12247. "Improvements in and relating to electric lamps or lighting apparatus." H. H. LAKE. (Communicated by G. C. Pyle, United States.) Dated August 5. (Complete.)
12337. "The indestructible electric filament used for incandescent electric light." C. HERZOG. Dated August 7.
12352. "Making electric contacts for ringing electric bells, and other purposes." A. H. BAGNOLD. Dated August 7.
12394. "Composition brushes for electric lighting." W. P. ODLUM. Dated August 8.
12422. "An electric pendulum for firing ships' guns." J. JENG. Dated August 8. (Complete.)
12439. "Improvements in and relating to electric lamps or lighting apparatus." A. L. SHEPARD. Dated August 8.
12440. "Portable combination electrical testing set." A. A. DAY and H. J. DOWSING. Dated August 8.
12504. "Improvements in holders for incandescent electric lamps." E. P. ALLAM. Dated August 9.

#### ABSTRACTS

#### OF PUBLISHED SPECIFICATIONS, 1889.

6458. "Method of regulating the electric current produced by electric generators driven by a motor having an irregular or variable speed." P. HOHO. Dated April 15. 1s. 1d. The object of the invention is to produce a current of a pre-determined strength, either constant or variable in a predetermined manner, in an electric machine, the speed of which varies within certain limits, by operating on the intensity of the field magnets. 5 claims.

9258. "Improvements in electric signal lamps and appliances connected therewith." F. L. RAWSON and W. S. RAWSON. Dated June 4. 8d. Surrounding the lamp are a number of blinds or shutters which may revolve on vertical pins and be actuated by a wheel or similar mechanism which by its motion engages with each shutter, and causes them to turn through about 90°. The motion of this wheel can be produced by the movement of an armature, due to the magnetic attraction of an electro-magnet. The passage of a current through the electro-magnet causes the armature to move and carry with it the wheel against the force of a coiled spring. By this action the shutters may be opened or shut. On the cessation of the current the spring carries the wheel back to its original position, and the shutters are shut or

opened by the wheel. By opening and closing the shutters flashes of light are seen round in all directions, and so can be used for signalling purposes. 6 claims.

10695. "Improvements in electric batteries." H. H. LAKE. (Communicated from abroad by C. A. Hussey and E. H. Brown, both of New York.) Dated July 2. 8d. Consists in the combination in a battery of a porous diaphragm for separating the two fluids, and extending solely in a horizontal or approximately horizontal plane. 4 claims.

10696. "Improvements in electric batteries." H. H. LAKE. (Communicated from abroad by C. A. Hussey and E. H. Brown, both of New York.) Dated July 2. 8d. Consists in the combination in a battery with a cell and negative and positive elements of a porous diaphragm arranged in the upper part of the cell below the positive element, and a piece of metal which is located below the porous diaphragm, and is of such character that it will decompose the salt of copper solution. 3 claims.

10878. "Improvements relating to electric telephones." D. B. MORISON. Dated July 5. 11d. The receiver and transmitter are mounted upon the extremities of a bent rod or of a bent tube through which are passed the conductors for one or the other of the said instruments, a part of the said rod or tube forming a handle, or being provided with a suitable handle of porcelain, wood or other suitable material. The conductors for both the transmitter and the receiver preferably extend through the casing of one or the other of the said instruments, and are connected with terminals attached to a suitable base or stand. The said tube is sometimes made telescopic or otherwise adjustable so that the relative positions of the two instruments can be varied. Another feature of the invention is the provision of a support for the said transmitter and receiver, which is so constructed and arranged that the weight of the combined instruments, when placed on the said support, will cause the interruption of the telephone circuit and switch in the signal or call-bell, suitable provision being made for automatically interrupting the signal or call-bell circuit and switching in the telephonic instruments when the latter are removed from the said support. 4 claims.

10940. "Improvements in electrical couplings used in electrically lighting railway trains, and for other purposes." F. T. HOLLINS. Dated July 8. 8d. The object of this invention, whilst still leaving this contact-piece or circuit closing device, perfectly automatic in its action when the couplings are taken apart, under ordinary circumstances is to provide that when the electric half-coupling at the slipping end of a slip coach is pulled apart from any other half coupling it shall, in coming apart, leave the contact-piece in the half coupling attached to the main portion of the train out of contact with the lamp circuit or lamp and battery circuit. 4 claims.

11179. "An electric meter." SIEMENS BROTHERS AND COMPANY. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 11. 8d. This invention relates to an electric meter, wherein a counter registers the number of oscillations of a bar of soft iron subject to the influence of the electrical current to be measured or of a known fraction thereof. 3 claims.

11191. "Improvements in roses for supporting electric lamps." W. A. S. BENSON. Dated July 11. 6d. The inventor connects the projecting ends of the leads in the wall or ceiling to contact makers, carried by a rosette of wood or other material fixed to the wall, like the rosette used for a gas bracket. The ends of the wires of the fittings are attached to spring contact makers, which are carried by a disc or cone similar to that used for gas brackets and called the "back." It is furnished with screw holes, so that it can be attached by screws to the rosette, as is done in fixing a gas bracket. 3 claims.

11528. "Improvements in electrode plates for electric accumulators." C. BEYER and G. HAGEN. Dated July 19. 8d. Relates to electrodes formed of a skeleton, which serves for the reception of the filling or active material, and which comprises two plates constructed in the form of openwork frames, nets, or gratings, that are connected by numerous cross-pieces, and are surrounded by a solid frame or border. 2 claims.

12444. "Improvements in switchboards for telephone systems." J. R. SMITH. Dated August 6. 8d. The object of the invention is to provide a switchboard specially adapted for telephone systems, which will enable any subscriber to make a direct connection with any other subscriber in the system without the intervention of a third party at a central office. 7 claims.

## CORRESPONDENCE.

### Cable Testing.

My attention has been drawn to a paragraph in the *ELECTRICAL REVIEW* for the 18th ult., to which absence from England has prevented me from replying earlier.

The paragraph in question is intended as a criticism on an article on cable-testing, which I published in

*The Electrician* for the 11th ult., and is of so weak and puerile a nature, that I should have refrained from commenting upon it, had I not felt that my silence, instead of being attributed to contempt for such unscientific criticism, might possibly, by some persons, have been construed into inability to reply to the attack.

I cannot boast myself a regular reader of the *ELECTRICAL REVIEW*, but, if I ever chance to take up a copy of this paper, I am always reminded of the tale of the Staffordshire miners, who are reported to greet the appearance of a stranger by "'eaving 'arf a brick at 'is 'ed." Whenever anything is done in connection with electrical engineering which is beyond the somewhat limited experience of the editors of the *ELECTRICAL REVIEW*, they do not fail to 'eave the 'arf brick at the 'ed of the electrical stranger, although in their hands it is neither so efficient nor so weighty a weapon as in the hands of the Staffordshire miner; and, instead of annihilating the "stranger," not infrequently recoils on the assailant.

But I must remind the writer, or writers, of the paragraph to which I am referring, that assertion is not argument, nor inaccurate statement, proof. If the method which I have described be so ancient a one it is a somewhat curious fact that it is not described in any of the numerous text-books devoted to cable testing, and it is a still more curious fact that telegraph engineers of large experience and considerable knowledge of cable testing should be admittedly ignorant of this "so simply obvious" (*sic*) a method.

I therefore challenge the *ELECTRICAL REVIEW* to justify the gaseous effusion which appeared in their publication for July 18th, by giving chapter and verse for their statements, that the method described is neither novel nor interesting, or to acknowledge that they now, as so frequently before, have written at random.

H. Cuthbert Hall.

In response to our request that independent testimony to the correctness of our statement should be given, we have received the following communications from a number of gentlemen to whom we tender our cordial thanks.—EDS. *ELEC. REV.* :—

Mr. E. MARCH WEBB, electrician-in-chief to the India Rubber and Gutta Percha Company, Silvertown, says :—

"The system is as old as described. The particular method of application may vary according to individual idea. It is well known, in one shape or another, to every electrician."

To Mr. Webb's communication we append another from a gentleman with whose text-book Mr. Hall may possibly be acquainted :—

"It is evident that Mr. Cuthbert Hall can have had no experience whatever of cable factories, or he would not have made such an exceedingly absurd claim of originality for the method of localising faults in insulated wires which he describes. There is not a cable factory in existence, I believe, where the method described, and modifications of it, have not been, at some period or other, in almost daily use; this I can testify as the result of 20 years' experience. It may be that the method is not specifically described in any text book, but the reason of this is that it is so obvious as not to require description. I may add that the method is in daily operation at the Gloucester Road factory of the Postal Telegraph Department, and has been so ever since insulated wire has been in use. Mr. Hall's remarks relative to the Editors' limited experience is amusing, seeing that these gentlemen have, with the exception of one firm, probably had a longer and wider experience in the testing of insulated wire for submarine cables and other purposes than anyone in the electrical profession.

"H. R. KEMPE.

"Electricians' Department, General Post Office."

Messrs. WALTER T. GLOVER & Co.'s Electrician informs us that the method of fault testing with revolving drums, described by Mr. H. Cuthbert Hall,

has been practised in their works for the past five years.

The MANAGER OF HENLEY'S TELEGRAPH WORKS sends us the following:—Referring to yours of 15th inst. The system mentioned was used by us over 20 years ago, but has been abandoned in favour of a more practical method.

My attention having been called to Mr. Cuthbert Hall's system of testing, and also to a communication from him in reference to it, I would state that the method devised by him, which I have no doubt he thought was original at the time he invented it, is at the least forty years old. The germs, and a good deal more than the germs of this method of testing, were introduced by my brother, the late C. F. Varley, to test defectively insulated wires in railway tunnels, shortly after gutta-percha covered wires replaced suspended ones for tunnel work. The faults were localised in the following way: one end of the gutta-percha covered wire was connected to one pole of, say, 300 cells of a sand battery, the other pole being earthed, a piece of flannel soaked in acid and water was wrapped round the gutta-percha wire and embraced by the fingers of a lineman who walked through the tunnel, passing the flannel tube over the outside of the gutta-percha covering; when the fault was reached, the lineman's fingers and body acted the part of a galvanometer, the current passing through him to the earth and the position of the fault was afterwards more exactly localised by an ordinary lineman's detector.

When gutta-percha insulated wires came into use for underground circuits, the Varley system of testing was further developed by its introducer at the Gloucester Road Telegraph Stores. The coils of insulated wire were wrapped on a drum in a *precisely* similar manner to that described by Mr. Hall, and passed through an insulated trough containing acid and water.

The battery employed was a carefully insulated sulphate battery of seven or eight hundred volts, the troughs being suspended by gutta-percha bands from the roof of the workshop. One pole of the battery was in electrical connection with the copper core of the gutta-percha coated wire, and the other battery pole was connected to one of the two terminals of a very sensitive horizontal astatic galvanometer, made by the late Mr. Henley, and which stood on a strong oak bench, resting on a solid brick foundation, the second terminal of the galvanometer was electrically connected with the trough containing the acidulated water through which the coated wire passed, by being wound on to a second drum.

I shall be well within the mark, I think, if I say hundreds of miles of wire were tested in the manner described, under the direction of the late Mr. Muirhead, who was out-door superintendent of the old Telegraph Company, and who had charge of the workshops and the Store Department at Gloucester Road. I should think it probable that Dr. Alexander Muirhead may remember seeing this system of testing in practical use when he was a schoolboy, seeing that his father lived on the company's premises, at all events, Latimer Clark will be very familiar with the system of testing introduced by my late brother.

I may mention that the late Dr. Wildman Whitehouse reinvented the Varley system, and finding he had been anticipated, he called upon my brother. I was present at the interview, which took place in 1859 or 1860.

Mr. Cuthbert Hall would really appear to labour under the hallucination that the stock in trade of the editorial department of the ELECTRICAL REVIEW includes, among other things, a plentiful supply of "arf bricks"; possibly *his* experience in electrical engineering is "somewhat limited," for were he better posted up, he would be very likely to know that the experience of the editors of the ELECTRICAL REVIEW in matters of testing, more especially in connection with submarine cables, is considerable. If he were to read

the ELECTRICAL REVIEW regularly, instead of taking it up *only* occasionally, he might possibly become more charitably minded, and be less disposed than he would now seem to be, to take a leaf out of the book of our very good friends, the Staffordshire miners, and "leave arf bricks at the 'eds" of the editors.

S. A. Varley.

Another correspondent writes:—"I have gone through Hall's paper in the *Electrician*, and also your leaderette, and I cannot see anything to alter in your remarks. The only fresh point I notice in Hall's paper is the fact that he cuts an aperture in the centre of the drum to admit the end. Now, no one but a tyro would do that. All cable drums and insulated core drums now-a-days have a hole cut at the side or end of the drum, so as to allow of the end, and as much more as may be required to be outside for testing, &c.

"Such a simple matter of testing is not usually described in text books, nor are methods of connecting up, &c.; the original method of fault-finding by passing through an insulated water trough will be found in Culley, and was known to everyone.

"In Kempe's last edition, describing Jacob's method (which, by the way, Hall does not seem to know), p. 438, testing for faults from core and using *two drums* is referred to. The test only is explained, and the simple connections required with a revolving drum are naturally not referred to or explained, they are 'simply obvious' to the meanest understanding. Moving contacts may vary according to one's ideas, but the method of testing described by Hall is ancient.

"I am told that testing has been carried out at Helsby and at Henley's, and also Siemens', with revolving drums. This must be so, especially with Jacob's test. When swift's are used, then connection is made either with a brush on the spindle, or the end is attached to a suspended connector working in a swivel.

"The insulated trough, with metal plate, I have used for this purpose in the long past, and in the present, it has been of the form adopted for testing joints by Clark's method of accumulation. This I found handy for both purposes, and my present one is built on same lines; but I added a slight improvement to my trough (which was insulated at the four corners by telephone knob insulators screwed in). I found my trough (2 feet about) rather short, for minute faults went through sometimes before the water got at them. I accordingly mounted in the centre of the trough a small drum, with a circumference of about 3 feet; two turns round this, and the trough gave me a practical length of 8 to 9 feet, with satisfactory results.

"It is very difficult to give any dates or particulars as to the use of this simple means of fault testing, but the method of testing G.P. wire through water in an insulated trough was employed when I was a boy. The use of a revolving drum *only* introduced a friction contact instead of a fixed one, the method of testing being the same."

#### Fall of Potential.

"Works Manager" may possibly prefer a rule which avoids reference to a table of resistances and the calculations often needed, and enables him to make use of the 1,000 ampères square inch table he already has. In similar cables the fall of potential varies directly as the length in yards (to and fro) multiplied by the current. In the example given,  $200 \times 10 : 75 \times 15 :: 2.2 : 1.2375$ . Stated as an equation fall of potential,  $e c$

$$= \frac{2.2 \times 75 \times 15}{200 \times 10} = 1.2375, \text{ i.e., a current of 15 ampères}$$

in a 7/16 copper circuit 75 yards long causes a fall of potential of 1.2375 volts. The result given last week is, by a slip, 1.275 instead of 1.2375: and the resistance of 75 yards 7/16 is given as .085 instead of .0825 ohm.

A. Whalley.

August 16th, 1890.

THE TELEGRAPHIC JOURNAL AND  
ELECTRICAL REVIEW

VOL. XXVII. AUGUST 29, 1890. No. 666.

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DELIVERY OF TELEGRAMS.

ANOTHER storm has been raised about the management of the Post Office. No sooner is the vexatious business of the telegraph clerks disposed of, than the attention of the public is brought to bear on the internal working of the telegraph department in regard to the delivery of telegrams.

Prof. George Darwin, towards the end of last week, sent a complaint to the *Times* as to the non-delivery of a telegram. The grievance, in the Professor's own words, is: "A friend recently telegraphed to me from America, addressing the message, 'Darwin, Cambridge,' and it was not delivered on account of insufficient address. He repeated the attempt three times, and I learn from the General Post Office that there are others of my name residing in Cambridge, and that it was impossible to know with certainty for whom the message was intended. The other persons are my brothers. The non-delivery of the message was the occasion of the unnecessary sailing of a friend to America."

There can be little doubt that the Professor's allegation is not altogether well founded, and that the fault lay with his American friend; but while regretting the circumstance, one might have placed it to the credit of unaccountable accidents from which human beings possess no immunity, had it not been followed by a long series of like complaints. The Professor, as it were, had applied the match, and the explosion resulted in due course. This opening of the subject has given the opportunity for many to air their opinions as to desirable alterations.

Lord Sackville Cecil, in his letter, draws attention to other points besides transmission, which require speedy attention. It is known that telegrams handed in late in the evening at many offices are sometimes kept over until next morning. This is considered by some to be a gross breach of contract on the part of the postal authorities, but people who show

a desire to ventilate supposed grievances speak, in most cases, without any knowledge of the regulations affecting the transmission of telegrams. No one thinks of using the telegraph wires except in urgent cases, and if a letter would reach its destination in the same time as a telegram, it is asked, where is its use? It is, of course, incumbent on the office to see that a message is delivered as quickly as possible, or the official should state frankly to customers that he will not undertake to deliver them the same evening. This course is, we believe, generally pursued, although there may be instances in which the telegraph clerk is as ignorant of the regulations as the sender of the message. It is clearly incumbent upon the public to know in what the contract which is said to be broken really consists, otherwise it is sheer folly to fill the columns of the daily papers with complaints which have no existence in fact.

MANUAL TRAINING.

IN a recent issue of the American journal, "*Bradstreet's*," a description is given of the School of Manual Training at Baltimore. This institution claims to be the pioneer public manual training school, as well as the only absolutely free school of the sort in the world. The school was opened in 1884 with 60 pupils and 4 teachers; the scholars now number 549, with 15 instructors. The principal object of the training is the teaching of manual work, the literary instruction, which forms the chief motive of ordinary schools, being here but a department. The teaching of trades is not so much a desideratum as education in the use of tools and the early stages of mechanical industries.

The regular course extends over three years, but a shorter course of two years is suited to those who are unable to go through the longer training.

The daily work comprises instruction in the shops, draught-rooms, physical laboratory, and literary classes. During the first year of training, 15 weeks are devoted

to carpentry, 5 to wood-turning, and 20 to forging. In the second year, 15 weeks are given to pattern making, 5 to moulding, 15 to vice work, and 5 to soldering and brazing. Instruction is given as to the use and care of tools, designing work, and the nature of the materials employed.

Each class makes some special design for graduation, and this year a 10 horse-power dynamo, 13 lathes, and a Gordon printing press, have been undertaken.

The dynamo will be set up, and is expected to furnish a sufficient supply of electrical energy for the lighting of the buildings with incandescence lamps. The students also do all the plating required, and carry out all repairs to the machinery in use in the establishment.

There can be little doubt as to the value of schools of this nature, providing as they do practical instruction, and affording a means by which youngsters, who in after life must depend upon manual work, can readily give their attention to, and be guided in the study of, their individual bent. It would certainly appear desirable that in the higher classes of our Board Schools some attempt in this direction should be made.

#### Utilisation of Water Power.

IT would seem that the scheme for the utilisation of the Niagara Falls for the purpose of distributing power to a number of factories at Buffalo, has assumed a definite shape. A piece of land some distance above the Falls has been acquired, and a very strong syndicate has taken the work in hand. It is stated that 4 per cent. of the river flow will provide 120,000 horse-power, supposing that a fall of 140 feet is adopted. A lateral canal will carry the water required from the main river to vertical shafts, in which turbines, said to be the largest yet designed, will be placed. The town of Buffalo is 18 miles distant from the Falls, and it is as yet undecided as to the method to be employed in transmitting the power. The choice is not a large one, lying between rope transmission, as at Schaffhausen, compressed air, as at Paris and Birmingham, water pressure, as in London, and electricity. The Cataract Company has invited tenders, and the plans will be submitted to a scientific international committee. Meanwhile, a scheme of considerable magnitude is actually in course of execution at Helena, Montana, where the Missouri Power Company is building an immense dam across the Missouri River for the purpose of utilising the water power. The dam is a timber structure, 800 feet long and 47 feet high, and the reservoir thus formed will cover an area of about 429 square miles. The water will be carried through a tunnel to the turbines, and it is expected that 20,000 horse-power will be generated, the power being then transmitted electrically to the various mills.

#### How to Advertise.

A REMARKABLE supplement has been issued by our Italian contemporary, *L'Elettricità*. It consists of 24 quarto pages of illustrated matter referring solely to the Thomson-Houston International Company and to their exhibits shown at the Paris Exhibition. There are described the Thomson-Houston dynamo, three wire system of distribution, method of traction, alternate current dynamo, arc and glow lamps, electric welding, &c. In

the list referring to the lighting of Europe, the number of towns in which the system is in operation is given as 64, and several installations are to be found in some of these. The arc lamps in use in Europe comprise 3,836 and the incandescent lamps 17,055. Particulars are also given of the extensive use of the system of lighting and traction in America, and of which we gave details some time ago. The number, which, by the way, has only this week been issued as a supplement to one published a fortnight ago, winds up with testimonials, and is unique in the annals of technical advertising.

#### Cataphoric Medication.

IN the early autumn of last year Dr. Harries and Mr. H. Newman Lawrence made conclusive experiments on this subject and have since carried out this treatment, to which Dr. Harries gave the name of "Cataphoric Medication," in their regular practice at the Institute of Medical Electricity. In Mr. Lawrence's address to the City and Guilds' Old Students Association, published in the REVIEW of December 27th, 1889, he spoke of this treatment as in actual practice, and it is again mentioned in a note on the 8th of this month. Dr. Harries has referred, in his letter to us, to other dates in which he made the matter public.

#### Cable Testing.

THE letter which we publish from Mr. Cuthbert Hall does not show him in any better light than did his first communication; it was perhaps too much to expect the *amende honorable* from a gentleman whose character is so clearly defined by his writings. His reference to the Marchant engine, and other allusions, show him to be better acquainted with the REVIEW than he at first gave himself credit for; he might have gone further and acknowledged us as being the means of exposing that matter and bringing its career to a prompt and crushing end, but he evidently prefers dealing with half truths, probably under the impression that many of our subscribers may not be acquainted with the circumstances under which this incident took place. It will be noticed that all reference to Glover's and Henley's Works is carefully avoided, and as for the remainder of his remarks, we leave them to the tender mercies of such of our readers as may care to carry the matter further; or to the journal which first gave our correspondent publicity.

#### Kemmler's Execution.

THE *Scientific American*, of all the transatlantic papers to hand, seems to have taken the fairest and most impartial view of Kemmler's execution. After stating that the apparatus employed was sure and effective and that the criminal was instantly killed, our contemporary argues as follows:—"The most intelligent of the witnesses, disinterested persons, also the warden of the prison, declare that as a mode of execution the electrical plan is far preferable to the scaffold. It is rumoured the Westinghouse Company or some of its adherents spent many thousands of dollars in fruitless efforts to nullify and obstruct the operation of the new law. The ablest lawyers and experts, who ordinarily receive large fees, were employed. The execution of a criminal, whether by the guillotine, the garotte, the gallows, the gun, or the dynamo, is a ghastly business; and it is not surprising that the sensational newspapers, aided by the electrical opponents of the law, should have made the most of such an occasion to fill their columns with revolting details.

The foes of the law dwell upon the fact that the muscular contractions of the victim after the switch was turned prove the correctness of their original position—that Kemmler lingered a few seconds in life, that he was not instantaneously killed, therefore that electricity is a failure for this purpose, and the law should be repealed. We have only to say, if they are not satisfied with the electrical apparatus used at Auburn, if, as they claim, it is not effective, then let us employ the deadly devices which the complainants themselves use, own, and control, with which they fill our streets and slay our innocent citizens. Let them bring the culprit to our city prison, place him on a conducting floor, introduce one of their street light wires, and with it, at the moment of execution, touch the hands of the prisoner. It will extinguish life instantly. It has rarely been known to fail."

Edinburgh  
Exhibition Awards.

A GOOD deal of disappointment has been caused by the decision of the Executive Council, not to give awards in the electrical departments of the exhibition. We understand that this is in consequence of the London Chamber of Commerce and the Institution of Electrical Engineers refusing to appoint a jury. It is not a usual thing for the Institution to appoint a jury, and if it did not care about the task the exhibition authorities should appoint their own. We are aware that a stipulation was entered into with the London Chamber of Commerce on this matter, but if this body backs out the exhibition officials must look elsewhere. At any rate they should act fairly towards the electrical firms, many of whom may have been induced to exhibit in the hope of obtaining some reward in the shape of prizes. Were it not from the fact that awards were understood to be forthcoming the matter would not be worth discussing, for, after all, the value of exhibition medals or certificates is more apparent than real. Probably it was found impossible to get together a body of experts to undertake a series of exhaustive and lengthy tests without paying heavily for their services, and awards for merely showing apparatus give no legitimate representation of the standard of excellence to which the manufactures of any firm have been brought. As the matter stands the proceedings are calculated to render exhibitors more and more averse to participating in "International" shows, into which they are so frequently entrapped by specious promises made under the cover of high sounding patronage, and from which they apparently reap so little benefit.

Yet Another  
Alternator.

IN Messrs. Pyke and Harris's letter, which appears in another column, the principle of the new Thomson alternator is claimed afresh. We have examined the patent specification of Pyke and Barnett, and observe that the machine they refer to is indeed similar in principle to that of Prof. Elihu Thomson. In the application of the principle, however, it rather resembles Kingdon's. The lines of force do not pass through the axle, as in Thomson's, the magnetic circuits through adjacent generator coils being completed by inductor segments attached to rotating wheels. We cannot describe the machine in detail without a diagram, but may mention that it has one magnetising coil wound in two sections, four circles of projecting stationary cores with generator coils on them, arranged two concentrically on each side of the magnet, and two magnetic inductor wheels. As we have shown, the application of this principle is at least as old as 1883, probably older; but

if there is any inventor prior to Lever, who had similar ideas, he has not yet urged his claim.

An Electrical  
Patriarch.

IN a circular card, which Messrs. Sydney F. Walker and Co., are sending out, there is attached the following note:—"Our Mr. Sydney F. Walker claims to be the oldest living electric light engineer in the kingdom, if not in the world, he having been electrician to the proprietors of the first dynamo machine that was introduced into this country." Is not the unbounded assurance of this electrical patriarch appalling? Possibly more than one individual in the profession who would be apt to characterise Mr. Walker's work as the production of the oldest electric light engineer on the grounds that it would not reflect too great credit on the youngest; indeed, we have heard on good authority, that his dynamos bear traces of being built on the lines of "the first dynamo that was introduced into this country." This, however, we cannot vouch for, but we would like to hear from Mr. Walker on what he bases his claim, as we know something of "the first dynamo machine that was introduced into this country."

The Telegraph  
Service.

A MEDICAL man suggests the following remedy for the "address insufficient" grievance, of which those who frequently make use of telegrams are now complaining in the columns of the *Times*:—"Let no message be taken at a telegraph office with a paid reply without receipt of a full and sufficient address from the sender. Let all paid replies be sent to the office whence the first message was issued, and in case of difficulty, let a telegram whose owner cannot be at once found be referred to the post office." The theory that the non-delivery of telegrams is due to the employment of careless boys, whereas letters, which rarely, it is said, miss their destination, are in the hands of experienced and trustworthy men, scarcely explains the matter. If a letter is addressed to "Darwin, Cambridge," the postman probably gives it to the first person of that name he comes across in his rounds, and if it happens to be for another individual, he eventually receives it through the information contained therein. But, in innumerable instances, letters are returned to the sender with "Not known," &c., written across the envelope, so the telegram fault evidently does not lie in the employment of boys in lieu of men.

Fire Office Rules.

WE are all agreed that there should be a standard set of fire rules for electric lighting, but while electricians, like doctors, disagree, we seem as far off this desirable end as ever. Professor Silvanus Thompson lauds Mr. Heaphy and the Phoenix rules to the skies, and suggests their general adoption on the grounds that they have stood the test of time and are workable. Mr. Verity and Mr. Campbell Swinton, both men of practical experience in the wiring and fitting of houses, a matter in which Professor Thompson cannot claim a like advantage, hold the opposite view with very good reason, as a perusal of their letters to the *Times* will show. We agree with these gentlemen so far as their objections to the Phoenix rules are concerned, although we consider that the Institution of Electrical Engineers need not be concerned in the question at all. The desired result should not be difficult to arrive at by a judicious combination of supply companies, contractors, and fire offices, and we shall probably refer to this important topic more lengthily in a future issue.

## ELECTRIC RAILWAYS AND OCEAN CABLES.\*

By T. D. LOCKWOOD.

I HAVE read with a good deal of interest the communication of Mr. Cuttriss, in *The Electrical Engineer* of August 6th, concerning the disturbances manifested in his cable-receiving instruments, which he attributes to the operation of an electric street railway, at a distance of upwards of half a mile therefrom; and with equal interest the editorial comment on said article.

Though it is doubtless often unpleasant to be like Mr. Cuttriss and myself on the physically weaker side of a controversy, that position is not without its offsetting advantages, in that we are forced to study, and let us hope sometimes to master, the problems they involve; while persons working with less delicate appliances and with the electrical pursuits which cause, as distinguished from those which suffer from, the disturbances, are often and naturally content with a perfunctory examination of the matter.

As I have read the two articles, I gather that the disturbed cable circuit comes into the station from the sea conductor, passes through the instruments at the said station and then back by way of a closely parallel insulated conductor in the same cable to earth at the cable armour.

If I have correctly interpreted the arrangement, it is first to be observed that it is not as stated in the editorial comment "a complete metallic circuit," but simply a loop of an earth completed circuit, the two wires of said loop being parallel.

I should scarcely expect that any such disturbances as are described arise from magnetic induction, and in the light of experience do not believe they do, not so much, however, because the wires are looped for a certain distance, as from the fact that in addition to said looping, they are buried; they are underground; both conditions would tend I think to adversely affect magnetic induction.

I am inclined to believe that the disturbances have a twofold cause; that they are partly due, as Mr. Cuttriss suggests, to actual conduction through the intervening earth and water from the earth side of the electric railway circuit to the cable armour, and thence by way of that conductor, which is grounded on the armour, and through the instruments to the cable main conductor; and also in part attributable to the actions and reactions of electrostatic induction, which in such a case are likely to be complicated.

We may consider the earth, if of favourable constitution, to be heavily charged by the electricity poured into it from the cars.

It is not difficult to conceive that such a charge in the medium surrounding the buried cable will tend to attract a like charge of opposing sign, through the dielectric on both conductors of the cable. Thus if the earth be charged to a given plus potential by the railway, the two parallel conductors of the cable loop will both be the recipients of a minus charge. But this charge must come from somewhere, and as the armour earth terminal is nearer than any other, the major part of it comes from that point. But there is another reaction; the two sides of the loop are of unequal length, and it may well be imagined that the charge on the short side, that grounded on the cable armour is thicker, if I may so express it, than is that on the long leg which is but the end of the main cable conductor. The two will tend to react on each other, and the amount of the perceptible reaction will be the difference of the two charges.

But of course, any change in the potential or degree of charge in the surrounding earth, will eventuate in a redistribution, and a rearrangement of the charge in the cable; and such a rearrangement amounts virtually to a circulation of current. And as all changes or transfers of electricity from one side of the loop to the other must pass through the instrument, we necessarily have the undesired operation of the said instrument.

The editorial says: "There will, of course, be a solution for the difficulty, but it will be interesting to see just what it is." The solution of the difficulty is, in my opinion simply the use by either party of the complete parallel wire metallic circuit, imperfectly and at a high cost, by the cable company, whose property is trespassed upon; or in a practically perfect way, at a comparatively low cost, by the railway company, who is doing the trespassing.

## ELECTRICAL SIGNALLING APPARATUS.

IN presenting the report of the Comité des Arts Economiques upon the results of the competition established in 1884, by the Société d'Encouragement pour l'Industrie Nationale, relative to the invention of an apparatus for announcing the passing at a distant point of railway trains, M. Rouselle said the result of the competition had been the bringing to light of several interesting devices, but no definite decision had been arrived at, although the time for fulfilling the conditions had been ultimately extended to 1889; the value of the prize had also been raised from 2,000 to 3,000 frs. The several prorogations which had taken place had been necessary, in order to allow of the exhibits being properly tested by actual practice. The competitors numbered fifty, and many new and ingenious ideas had been put forth, notwithstanding which, only two of the competitors, viz., Messrs. Baillehache and Clémandot, the latter a member of the Société, had been able to establish their claims, M. Baillehache's device consisting of an insulated counter-rail, placed at the point from which the train in movement starts the signal, and in connecting by a wire this counter-rail to the station at which the signal is received, and which is furnished with a battery and an alarm. The springs of a passing train establish a connection between the two rails, and a circuit is formed, which, having traversed the wire connecting the two posts, returns to the earth and is closed by the springs. The alarm is sounded, and not only announces the presence of the train, but also its speed and the number of carriages composing it. A very useful, and even necessary complement of the system, is a controlling wire, by which the circuit is closed when the commutator button at the receiving post is pressed. By this the agent is in a position to satisfy himself that the apparatus is in working order.

M. Clémandot's system, which possesses the important advantage of dispensing with any moveable accessories in establishing the circuit, is based upon the difference between the electric resistances of two lines of rail, according as they are united by the wheels and springs of the train, or they are free. At the signalling point, a battery and an electromagnet are placed at the sides of the line; at the receiving station a relay is established by means of another battery and magnet and an alarm is established in derivation. Two wires form the connection between the two stations. Under ordinary conditions, a continuous current traverses the whole extent of the circuit. When a train is passing the armatures of the electromagnets are displaced, and the normal current is replaced by two local currents, one of which, at the signalling station, is closed by the springs of the train, whilst the other, at the receiving station, traverses the alarm in derivation and sets it going.

Notwithstanding the thorough testing over a period of several years, on various railway lines, which these apparatus have undergone, the committee remains undecided. Both systems, in fact, have been impeached as open to serious objection, sometimes on the score of safety. The committee, however, expresses the hope that so much skill, ingenuity, and knowledge on the part of the inventors will not have been expended in vain. The Society is unable to award the prize to either, but a distribution has been made as a recognition, to some extent, of the value which attaches to their labours.

\* See last week's ELECTRICAL REVIEW.

M. Baillehache will, accordingly, be awarded 1,000, and M. Clémandot 1,500 frs., as it is considered that the latter's system affords the better guarantee of safety, a consideration which the committee judges to be of supreme importance.

### HIGH POTENTIAL STORAGE BATTERIES.

IN one of his early patents, Mr. Faure describes a method of arranging lead plates in such a manner that connectors and separate receptacles can be dispensed with. Plain sheet lead, pasted on both sides with red lead, is packed between elastic frames, constituting three sides of a cell open at the top. The space thus produced between the plates is filled with the electrolyte, the first and last electrode of a series of such cells being then connected to the source of supply. With the exception of the end plates, each intermediate electrode will become negative on one side and positive on the other. The capacity (in ampère hours) of such an accumulator is necessarily limited to the dimensions of one plate, and the electromotive force is proportional to the number of plates. A similar battery has recently been invented in New York, called the "Dey Series High Potential Storage Battery." Mr. Dey uses a hard Indiarubber case made of sheets which are screwed together. This is lined with a soft rubber box having ribs running down the sides and across the bottom. The lead plates, which have a raised rim, slide down the grooves formed by these ribs, and when the side is screwed on it forms watertight joints between the ribs and plates. The plates are made grid fashion, with a web or partition down the centre and projecting half-an-inch above the active material to keep the acid separated. The active material is applied in the form of a dry powder, red lead being placed on the positive side and litharge on the negative. The plates are 9 inches by 15 inches by  $\frac{7}{16}$ ths thick, placed  $\frac{3}{8}$ ths inch apart. A complete cell containing eleven whole plates and two half or end plates, has a normal output of 94 ampère hours, and an E.M.F. of 24 volts, and it weighs 210 pounds. This does not show any advantage over existing types with separate cells, which are preferable for various reasons. Mr. Dey has a novel arrangement for cutting out of circuit the battery when fully charged, somewhat, we think, on the lines of an apparatus used in the old Colchester installation. This cut-out consists of an inverted U-shaped tube which is filled with acid and suspended on the plate. The gas from a fully charged cell rises into the tube, displaces the acid and thus causes the tube to move upwards against a spring making contact with the apparatus which operates the cut-out. The Sawyer-Man Electric Company use two series of six cells in their photometer room, giving an E.M.F. of 144 volts. Plates of this description will necessarily buckle, as the positive side alone expands. Concerning this defect, Mr. Dey maintains, "that when they do buckle (which occurs rarely) they all buckle in one direction (positive side out) and fit into one another like saucers." It must be an interesting sight after, say, a year's continuous work, if the arrangement can hold out so long.

### THE RELATIVE POSITION OF GAS AND ELECTRIC LIGHTING.

IT may perhaps be interesting if we refer to the relative present position of gas and electric lighting, and in order to do this we must review the status of the two illuminants during the past three years. In 1887, 1888, and during the first half of last year, gas companies, and the supporters of the older light regarded with indifference the gradual increase in the use of the electric light, and the consensus of opinion arrived at by them was that there was not the slightest fear that electricity for illumination purposes would be a formidable competitor of gas. Statements to this effect were frequently

made at the meetings of the gas companies, and the shareholders were assured that the possibility of the use of the electric light acting detrimentally to their undertakings was entirely out of the question. As time passed away there came into existence numerous companies for lighting by electricity the most remunerative—to gas companies—London districts and provincial towns. In some instances the gas companies opposed the applications made by electric light companies for Parliamentary powers, but their opposition was unsuccessful. Such was the state of affairs some time ago.

At present, however, the position is entirely changed. The inauguration of new central electric light stations, and the erection of others throughout the country, have caused some gas companies to recognise the fact that the electric light is not only a competitor, but that it is also gradually superseding gas in many large establishments, which were formerly considered among the most profitable customers to the gas companies. To show to what extent this condition now prevails, we may mention that in the metropolis alone the two largest companies—the Gas Light and Coke and the South Metropolitan—have sold considerably less gas during the half-year ended June 30th than in the corresponding half of last year. The amount of the dividends paid has also diminished, that of the former company being 13 per cent., as compared with  $13\frac{1}{4}$  in the corresponding half of 1889, and that of the latter being 12 per cent., as against  $13\frac{1}{2}$ . Moreover, the Gas Light and Coke Company found it necessary some time ago to increase the price of gas by 3d. per thousand. In these two instances the diminution in the consumption is, of course, not considered by the companies concerned to be due to the competition of the electric light; but it is significant that they are seeking new openings for the use of gas—a fact which leads to the conclusion that the two companies are fully aware that in certain districts they cannot possibly expect to increase the sale of gas for lighting purposes, and that the diminution already taken place must to a certain extent be attributed to the gradual adoption of the electric light by those who are prepared to pay for it. Again, the directors of provincial gas companies no longer consider their position impregnable, and they are therefore following the example of the London companies by endeavouring to extend the uses of gas, and at the same time keeping a watchful eye on the progress of the "coming" light.

It may appear surprising that the shareholders in gas undertakings should take the trouble to ascertain the position of the electric lighting industry; yet such is the case. We know of instances where the holders of gas stocks have asked financial journals, representing the gas industry, to explain the present position of the electric lighting business in so far as it related to the supply of gas, in order that they might decide whether to increase their shares or otherwise. Actions of this kind distinctly indicate the feeling of distrust on the part of some gas shareholders, for although in some instances where the electric light has been introduced the consumption of gas has augmented owing to its being used for other than lighting purposes, yet in others the reverse has been the result.

It would appear from this that the use of gas for lighting is slightly diminishing, but that for cooking and heating and motive power purposes it is increasing. It is therefore in these directions that gas companies will be able to augment the consumption, and to these three branches great attention is being devoted. The days of the "no competition" theory have passed away, and it is satisfactory to find that many gas companies realise the important fact that, notwithstanding its higher price, many consumers prefer to have the electric light.

**English Lighting Companies Note.**—The Continental Edison Company, which has a nominal capital of £400,000, actually supplied current during July in Paris to the extent of £3,220 gross.

## COMPRESSED AIR FOR THE TRANSMISSION OF POWER.

THE transmission of motive power by means of compressed air on the "Popp" system—an ominous name for English ears—is exciting some attention in Germany where efforts are being made to represent it as equal, if not superior, to the electric transmission of power. The report of Prof. Gusinde in favour of electricity, is being criticised by officials of the Berlin Compressed Air Company, and the respective assertions of these rivals are given by the Berlin *Finanzherald*, which seems to have a manifest leaning to M. Popp and his scheme.

As a specimen of the style in which this controversy is being waged, we may quote the following passage from Prof. Gusinde's report, followed by the reply of the Poppers. Says Dr. Gusinde—we believe with full truth: "In America, where numerous electrical central stations are at work, the compressed air system has nowhere found admission, whilst the electrical transmission of power has been for a long time introduced for all trade purposes and is continually growing in extent and importance. It may be here mentioned what prominence the electromotor has obtained in America in tramlines, whilst the air motor cannot undertake a competition in this promising region."

If this is true, it is an important piece of evidence against compressed air transmission. If it is not true, it is the duty of the Popp Company to show *when* and *where* air tramlines have been in successful operation, and what, if any, are their advantages over electric lines.

Instead of so doing, the Popp Company merely reply: "Tramlines with air-propulsion have been at work for some time." Where, and with what result, the reader is left to guess. They add: "It is therefore the duty of a serious critic to take the results of these air-tramlines into consideration." Surely, it is rather the duty of the Popp Company to adduce—if they can—any facts calculated to refute the statements of Prof. Gusinde.

Again, said the latter *savant* in his report: "The superiority of the electrical transmission of power is hence demonstrated." The reply is, "that the superiority of the electric transmission of power is not proved!" Here the Popp Company ought to have shown, or tried to show, some superiority on their side. But no attempt of the kind is made. Surely a different style of advocacy is needed to secure a favourable verdict from an educated public!

## WHAT CONSTITUTES A DANGEROUS ELECTRICAL CURRENT?\*

By NELSON W. PERRY, E.M.

## PART I.

THE question is continually arising as to what is a dangerous current of electricity, and the answers that may be encountered are usually so varied that the enquirer is prone to ask again with the result as unsatisfactory as before, and a conclusion that the electric fluid is as mysterious in its effects upon life as it is to most people in its other manifestations.

It would not be far wrong to state that the most general feeling in regard to this question at the present time is that, a given current might kill to-day and be harmless to-morrow; that what would be certain destruction of life to one individual could be safely borne by another. In fact, such a belief is but a consequence of that very common opinion among the laity that electricity is not amenable to infallible laws like other forces, or that if it is, then such laws are at present but imperfectly understood.

Such, however, is far from being the truth. It is

indeed very common to hear the statement that we do not know what electricity is—but how often do we hear the statement that we do not know what gravity is?

How many of us if asked the question would hesitate for a moment in stating that we were in possession of full knowledge in regard to gravity and yet at the same time would delegate electricity to the unknown, and perhaps to the unknowable? And yet of the two, much more is actually known to-day about electricity than is known about gravity. In fact, the electro-magnetic theory of light so beautifully formulated by Clerk Maxwell has received at the hands of Prof. Hertz within the past two years, experimental demonstration, and we know beyond peradventure that electricity is a phenomenon of the ether in the same sense as light is.

We cannot say that we know all the laws of light—we know a great many of them—in fact, nearly all that are necessary to explain the phenomena with which we are confronted, and we find that these laws are all absolute in their workings—they are infallible.

So it is with electricity. If we do not yet know quite what it is, we are certainly much nearer a solution than we are in the case of gravity. It would be folly to say that we know *all* the laws of electrical action, but we probably know even more of its laws than we do those of light, and they are in no way less certain. In fact scientists have long since come to the conclusion that the laws of nature are all infallible. It is a fundamental doctrine of science that under like conditions like results must inevitably follow. There are no miracles in science; there may be mysteries, but they are mysteries because of our ignorance of the conditions, and not because of the abeyance of any of nature's laws. The difference between the scientific mind and the unscientific mind is that if an apparent contradiction of an accepted law is noted, the former assumes some condition not understood, and the latter immediately assumes it to be what it appears, viz.: A direct contradiction of the law.

To the latter such a thing is not so very remarkable—the world is full of just such contradictions; it is therefore not inconsistent with previous experience, and it does not even excite surprise. To the scientific mind, however, such a thing as the fracture of a law or its abeyance for one instant is an utter impossibility and unthinkable.

Electrical science to the unscientific mind may logically be a department of contradictions; but to the electrician it is one of fixed and inviolable laws as are all the other sciences; and what is more it has arrived at a position of an exact science in which results can be predicated from given data with mathematical exactitude and precision. In fact astronomy does not rest upon a more sure mathematical basis than does the science of electricity.

Electricians are sometimes asked to explain many things that never occurred; for instance, it is universally acknowledged that 110 volts—that usually employed in the incandescent light is perfectly safe as far as life is concerned. Yet not long ago it was announced all over the country that a little coloured boy was killed at Chattanooga by coming in contact with an incandescent light wire of 110 volts, and electricians were asked to explain how this could happen. It could not be explained, and was not until the coroner's inquiry developed the fact that no electricity had been on the wire for over a half an hour previous to the boy's coming in proximity to it, that the boy did not die from an electric shock, and that the burns that were attributed to the electric current were due from an oil lamp which the boy had in his hands, and not to the electric current.

And then supposing the statement were true, and it is not questioned anywhere, that a current of 110 volts such as is usually employed in incandescent lighting is perfectly safe, yet it is not true that it is safe to touch every incandescent circuit one meets. Most of our electric street cars are operated by a current of 500 volts pressure. In all such you will observe five electric lights, similar to those you see in the stores. Now while each

\* *Western Electrician.*

of these lights is only called upon to stand a pressure of about 100 volts, they are placed in a row or in "series," so that the same current passes through each in succession, and meets with the combined resistances of all of them. In such a circuit five lights of 100 ohms each resistance can be opposed to a pressure of 500 volts, and yet the effect would be to subject each individual light to a pressure of one-fifth the amount, or 100 volts. One can, however, take his choice of shocks due to 500, 400, 300, 200, and 100 volts, according as he short-circuits five, four, three, two lamps, or only one.

In case an electric road were operated by a current at 1,000 volts, it is evident that ten 100-volt lights could be operated in series in each car, and under these circumstances the seeker after sensations could get anything he wanted in the way of shocks from that due to 100 volts pressure up to that due to 1,000 volts pressure. That it is quite evident that while the first statement might be perfectly true if comprehensively understood, yet it would not be advisable to assume that all incandescent light circuits, or even all circuits containing 110-volt incandescent lights were safe. And again, as we have seen that in the 1,000-volt circuit all pressures from 100 volts to 1,000 could be obtained according to the point where one touched the wire, so it would not be safe to assume that because I touched the circuit with impunity at one point you or anybody else could do the same at another point. And yet this is just what would be assumed by the majority of people, and if you were killed, and I was scarcely shocked, it would be referred to as an illustration of the idiosyncrasies of the electric current.

A couple of summers ago I was present at the starting of a new electric underground railroad in one of the coal mines in Pennsylvania. The trolley wire—to use an Irish bull—was a light T-rail, supported on timbers overhead out of reach of persons standing on the ground. At one point there was a switch by which the current could be turned on or off, and on this day, as it was desirable to have this readily accessible, a large wooden block was placed on the ground underneath it. By standing on this, one could readily reach the trolley rail and switch. Had the block been a perfect insulator, a person standing upon it could have touched the trolley rail without the slightest shock, even though there had been 5,000 volts instead of 350, as was the case; but as it was, the conductivity was just sufficient to give one standing upon it, and touching the rail, a right smart shock, and the whole thing being new to the miners, they were amusing themselves by getting up and touching the rail.

One man, thinking to have a little fun at the expense of another, jumped upon the block, and while he touched the rail with one hand, grasped his intended victim, who was standing on the damp ground, with the other.

He thought to surprise his friend with a slight shock, such as he himself had been taking in fun before, but the joke was a huger one than he had anticipated, for, by grasping the other man's hand, he made a good connection with the ground, through his own as well as his friend's body, and the result was that both men were violently thrown to the ground, and so quickly, that they scarcely knew what had done it; neither man was hurt, but all had a great respect for that trolley rail thereafter.

Not many days from this time, a mule came in contact with this same trolley rail, and was almost instantly killed, and in falling he pulled his mate over in contact with it, and he, too, was killed. Now here were three different effects from the same current, yet the conditions being different, the results varied widely.

Now, if we were to try to reason by analogy, we should say—this current was strong enough to kill two mules, therefore these two men ought in all fairness to have been killed. But they weren't.

Again, among the miners it was argued that since one man alone on the block could easily stand the shock, and two men catching hold of hands were both thrown to the ground, if three or more had hold of each other, they certainly would have been killed.

The electrician readily sees the fallacy in the last argument, but he does not see how the mules should have been killed while the men escaped. He merely knows from numerous instances, of which this was one of the first recorded, that mules and horses are very much more susceptible to electrical influences than is man. Why, he does not pretend to say any more than he does why a pig will fatten on arsenic or antimony which are fatal in small doses to man. The physician can tell, perhaps, but not the electrician, and the physician had to learn the fact from experience; there was not a *priori* reason why it should be so.

This calls to mind an amusing story that I once heard as to the origin of the term "Antimony," which is the name of a metal closely resembling arsenic in many of its properties.

Some monks had found a new mineral and had prepared from it a new metal, which, so far as they could see, proved to be utterly worthless, so they threw it away. It fell within reach of some of the hogs belonging to the monastery, and the monks noticed that they devoured it with apparent relish. Curious to know the effect of such a diet upon the swine, they fed them regular with it for some time and found that they not only prospered, but grew enormously fat upon it. Some of the monks reasoned that if it was so good for the hogs it ought to be good for themselves too, so some of them partook of a liberal dose of it, resulting in their speedy horrible death by poisoning. The new metal was therefore called "Anti-Moine," which by slight change has become Anti-mony.

The authenticity of this origin for the term is very seriously doubted, but the story serves to illustrate that the fact that 350 volts is fatal to a mule while it is not to man, rests upon the same experimental data that the other fact does—viz., that a hog can eat some things with profit that are not conducive to longevity in man.

Now, while I know of no *priori* reasons why a certain quantity of electricity should be fatal to man, still I believe it to be an established fact that the quantity that will be immediately fatal can be fixed with as much certainty as can the fatal dose of any of our well-known poisons, and I think it is now surely settled that a single ampère of current caused to pass through the vital part of the body is much more certain to be instantly fatal in all cases, and, in any case, than is hanging by the neck; and I think the question "is hanging necessarily fatal?" much more doubtful than is the other one—"is one ampère of electricity necessarily a fatal dose?" and the answer to both of them is "Yes, if properly applied."

A man may be hung by the neck without breaking it, or he may be hung by the hand or by the waist, and if not kept suspended too long, there will be little danger of death. So may a man take one or several ampères of current through the hand or leg or foot, or other non-vital portion of the body, and be not permanently disabled, but I do not believe that it is possible for him to take one ampère in such a way that the brain or the heart are in the direct line of the current without instantaneous and painless dissolution.

It has for a long time been generally admitted that one ampère of current, if properly applied, was considerably in excess of that required to produce instant death in man—there has practically been no question as to that, but the question has been how great a voltage was necessary to ensure the passage of an ampère of current through the body. It has been supposed, and there has been much testimony adduced in support of the supposed fact that the resistance of the human body, and therefore the electromotive force necessary to drive a given quantity of electricity through it, was such a varying and variable quantity that measurements made of the resistance of certain individuals at one time were of absolutely no value in the case of other people, or even in case of the same people at a different time. In fact, there seemed to be some ground for believing that the human body offered very different resistances to currents of different potentials, and if this were so, a determination of the resistance to the milder currents, that could be used without disagreeable con-

sequences, would be of absolutely no value in arriving at the resistance that would be opposed to currents of higher pressure.

The importance of knowing the resistance of the human body at the time of experiment is essential in arriving at either the number of ampères that a given electromotive force will drive through it, or the number of volts that are necessary to force a given number of ampères through it.

As late as last summer, there was nothing but the most contradictory evidence on this all important point, if we are to take the evidence of electrical and medical experts who appeared before referee Becker in the Kemmler appeal.

One expert found, upon testing the resistance of a certain electrician, these results :

With a current of 1 volt the resistance was	6,300 ohms.
" " 10 volts " "	5,140 "
" " 50 " "	3,850 "
" " 100 " "	3,500 "

The current was passed from one hand, through the body, to the other hand, perfect electrical connection being provided for by moistening the hands with a solution of sulphate of zinc. These experiments seemed to indicate that as the electromotive force increased, the resistance of the body decreased.

Next a newspaper man was tried. Connection was again made by means of a solution of sulphate of zinc, but in this case the current was passed from the head to the feet. As was perhaps to be expected from the subject, the average resistance was much greater.

In the first experiment it proved to be	7,097 ohms.
" second " " "	6,297 "
" third " " "	6,092 "

Newspaper men are proverbially early risers, but the electrician is not to be outdone if he knows himself, so the next witness to testify was an electrician who had tested his own resistance from hand to hand with the following results.

Using the current from one cell, his resistance was 80,000 ohms.

Using the current from 10 cells his resistance was 37,000 ohms.

Later, using the current from one cell, his resistance was 31,000 ohms.

Later, using the current from 10 cells, his resistance was 24,500.

Two minutes after using the current from one cell, his resistance was 36,000 ohms. Using the current from 10 cells, his resistance was 21,500 ohms, and in the final tests with one cell, he found his resistance to be 21,600 ohms ; with 10 cells he found his resistance to be 16,000 ohms.

These figures seemed to show two things—first, that, as the electromotive force experimented with increased, the resistance of the body decreased ; and, second, that, in a series of experiments following each other in rapid succession, the resistance very rapidly decreased.

The significance of these figures is apparent when we remember that, in order that one ampère of current shall be forced through a resistance, the electromotive force, measured in volts, must exactly equal the resistance, measured in ohms.

Thus, from the preceding testimony, we find a variation in resistance from a maximum of 80,000 ohms, which would require an electromotive force of 80,000 volts, if one ampère is the current required, down to a minimum of 3,500 ohms, through which it would require a pressure of 3,500 volts to force the same current—a variation between maximum and minimum of nearly 2,300 per cent., and in the case of the same individual, at different times and different potentials, a variation from 80,000 to 16,000 ohms, or 500 per cent.

It is evident, if these figures are reliable, no value whatever is to be attached to measurements made at one time in determining what the resistance would be at another.

It was known that the skin offered the greatest resistance to the passage of the current, and it was readily

surmised that in different individuals greater or less callousness might be responsible for very great variations, and in the case of the same individual it was readily to be conceived that the difference in the condition of the skin as regards moisture might have a controlling effect in the measurement of the resistance of the body, and a moistening of the hands with a solution of sulphate of zinc—a good conductor of electricity—was resorted to in the first two cases cited, to remove this difficulty as far as possible, and to insure better contact. But zinc sulphate is a powerful astringent, and has a tendency to harden the epidermis and prevent its absorption of moisture, or its exudation in the form of perspiration, and, as might have been foreseen, failed to accomplish the object for which it was intended.

Thomas Edison had foreseen the objection to the use of sulphate of zinc, and also another, viz., that it would be totally impotent to remove the insulating effects of the oily exudations of the skin, and in other respects, since the resistance would depend very much on the tightness with which the electrodes were grasped by the person, it would be very difficult to obtain the same conditions with two different persons, or to maintain them the same with the same individual during two successive experiments.

So in his experiments to settle the question in his own mind as to the resistance of the human body he chose a liquid for moistening the skin that was not only not an astringent, but rather the reverse, and which at the same time was deterative and would saponify the grease.

In a solution of caustic potash he found just such a fluid, and he eliminated the uncertainty due to the variability of pressure upon the electrode by causing his subjects to place themselves within the circuit by immersing each hand in a metal jar of this solution which was connected electrically with his battery.

Following this method, by which he sought to maintain his conditions more uniform, he tested the resistance of 250 subjects—probably by far the largest number that has ever been tested under even approximately similar conditions, and found *their average resistance* to be 1,000 ohms, and out of all this number the extremes were 1,800 and 600 ohms.

He also found that the resistance of the same people at different times was practically constant—the maximum variation of the same individual at different times was 50 ohms, or 5 per cent. of the average resistance.

Thus we see order again brought out of chaos.

The experiments have since been repeated, though not on the same scale, with results so concordant that it is now considered a pretty well settled fact that the human body does not vary more widely in its behaviour toward electricity than it does toward other things—drugs or poisons for instance, and the normal resistance of an adult body is a pretty well-fixed figure, and the maximum variation from the figure as determined for the individual does not exceed 5 per cent. under ordinary conditions.

## ELECTRICITY IS LIFE.

It is said, although we confess that we have not yet experienced the sensation, that before a thunderstorm everything has been so still for days that the oxygen in the air has been to some extent deprived of its life-sustaining power, and a feeling of drowsiness comes over all. The air has been partially devitalised, and is not fit to produce in man to the same degree the usual vitalising effects. But the lightning flashes restore the lost energy to the oxygen, and a feeling of exhilaration is experienced after the thunderstorm is over. "What the electric flashes effected in the devitalised air of the chamber in which the experiments on the animals were made, the lightning effects in the weakened air during sultry close weather ; vitalising power is restored to it." The quotation is taken from a contemporary, in which certain experiments on animal life are described as

follows:—"After several animals had been breathing in a chamber of pure oxygen, Dr. B. W. Richardson collected the gas in the chamber and freed it from all but the oxygen, so that no chemical test was able to show any difference between its character and composition and those of freshly-made oxygen gas. When he passed this purified oxygen for the second time into the chamber, the animals soon became drowsy, and on repeating the experiment by successive purifications of the exhaled air the animals died. He concluded, then, that oxygen which had been repeatedly passed through the lungs of warm-blooded animals, however thoroughly purified from carbonic acid, watery vapour, and ammonia, no longer maintains life. It has become what is scientifically called "devitalised." But the startling discovery still remains. He passed through the devitalised oxygen currents of electricity from a set of brushes connected with the positive pole of a frictional machine, and the gas had its vital energy restored; animals again lived in it with the customary sprightliness. He discovered that electricity restores to its vital state oxygen which has been rendered noxious by passing through the lungs of animals."

We are not aware whether these experiments are of recent date or not, but they are sufficiently remarkable to lead to the hope that the subject may be pursued further, for they appear to have a direct bearing upon our vitality, and suggest uses in domestic life for the frictional machine such as have not yet been heard of.

Equally suggestive are the results of applying electrical treatment to milk which, as is well known, tends to grow acid during thunderstorms. An Italian, Professor G. Tolomei, has lately tried to throw some light on the nature of this action. He experimented with electricity on fresh milk in three different ways—first, by passing the discharge of a Holtz machine between two balls of platinum inserted nearly two inches apart in a bottle containing milk; second, by sending a battery current between two strips of platinum at the bottom of a U tube holding milk; and, third, by subjecting milk in a test tube to the action of a strong battery current through a silk-covered copper wire wound spirally round the tube. In each case the acidulation was delayed, not hastened. Three equal portions of milk from the same milking, thus treated, began to grow acid on the seventh, the ninth, and the sixth day respectively, while milk not treated with electricity was manifestly acid on the third day. The electrified milk (unlike milk that has been heated to a high temperature, then cooled), coagulates naturally, or by action of rennet, just like ordinary milk. Having thus seen that electricity could not be the direct cause of acidification of milk, the professor next tried the effect of ozone, and found it distinctly acidifying. In one case the surface of a quantity of milk was brought close under the two balls of a Holtz machine, and the milk soon became acid in consequence, the sooner if the discharge was silent (not explosive), in which case more ozone is formed. In another case ozonised oxygen was made to bubble up through a quantity of milk, which in a few hours was completely acid and soon coagulated spontaneously. Professor Tolomei is of opinion that oxygen probably also promotes lactic fermentation (a point which has been disputed). If milk keeps longer in wide, shallow vessels, that is probably due, he thinks, to the cooling produced by evaporation, which is favoured by a wide open surface. The only thing now required is that the same treatment should be applied to the purification of alcoholic drinks, in which at times people are apt to indulge too freely in the belief that good spirits promote a happy state of being, a judicious mixture of milk and spirituous liquor at early morn being calculated to bring about the desired effect.

**Acknowledgment.**—Through an oversight, the source from whence we derived the description of Mr. Field's telephone (*Electrical Engineer*, of New York), was not acknowledged in the article last week; we hasten to express our regret.

## ELECTRIC TRACTION DATA.

AMONG the first and most exhaustive power tests with electric cars were those made by Mr. A. Reckenzaun some three years ago in the City of Philadelphia, and they were published recently in a paper bearing the title of the present article. No less than three well trained men were required for the purpose of making observations, and recording them. Thus, on one occasion, during a run of 43 miles, 7,500 ammeter readings were taken, which had to be written down at the rate of 20 per minute. Considering the very rapid variations of the currents used on uneven tracks, it is absolutely necessary that readings should be recorded in the shortest possible intervals, so that a correct average may be estimated. This process is extremely tedious, and liable to error, in spite of the greatest care of a skilled hand and eye, and many have been the attempts to devise an apparatus which should automatically record the power consumed on an electrically propelled vehicle. The jolting of a car has very little effect upon the extremely light needle of a dead beat ammeter; but the introduction of a pen or pencil must produce deviations due to the momentum of such moving parts of the instrument.

The *Electrical World* of the 16th inst. contains a description of a recording ammeter devised by Messrs. Hulett and Larned, which has been used in recent tests on the Thomson-Houston road at Syracuse, N.Y. This instrument is not free from the objections we have mentioned, yet it appears to have answered its purpose to a sufficient extent to give very approximate values. This apparatus consists essentially of a solenoid 7 inches in diameter, containing 80 turns of copper cable, through which the maximum current of 150 amperes may be safely used. The solenoid is fixed vertically upon a board, and it contains a movable iron core  $1\frac{1}{4}$  inches in diameter, which carries a pen at its upper end. This pen presses against a strip of paper upon a drum, which rotates by means of clock work. The magnetic attraction exercised by the solenoid upon the iron core is balanced by a spring, whose tension is so regulated that a pull of 10 lbs. will produce a deflection of 3 inches; the object in providing so great a force was to render negligible the friction of the core against the bobbin, and of the pen upon the paper and vertical guides. The circumference of the paper drum is 24 inches, and it rotates once an hour; the space allotted to record the variations is 2 inches for every five minutes, and this was scarcely sufficient, the vertical pen strokes due to the current changes coming in some cases too close to each other to render them distinguishable.

In order to obtain the mean ordinate for a whole day, it was necessary to integrate with a planimeter the space included between the curve and the zero line; thus the area was found which, divided by the length, gave the mean height of the diagram. As the movements of a core within a solenoid are not proportional to the current, the instrument was integrated in three parts, and each portion read separately from the calibration curve. The results thus obtained were considered to give a very close approximation to the truth. The object of these tests was to obtain (1) the efficiency of the station, (2) the efficiency of the line, (3) the efficiency of the cars. Ammeter and voltmeter readings were made every 25 minutes at the same time, while indicator cards were taken from the engines. The efficiency of the station gave an average of 62.8 per cent., i.e., the ratio between the electrical H.P. and the indicated H.P. The highest efficiency observed was 82 per cent. when the I.H.P. was 108; but when the I.H.P. dropped to 30 or below, the resultant efficiency did not exceed 40 per cent. The efficiency of the line was calculated from voltmeter readings taken at the station and line simultaneously, and averaged 91 per cent. Seven cars were on the road during these experiments.

The mean efficiency of the cars (motors and gearing) was calculated from observations at various speeds,

and found to be 65 per cent. The efficiency of the entire system, therefore, from the product of these results, amounted to  $62.8 \times .91 \times .65 = 37$  per cent.

The coal consumption has been ascertained to be 4,800 lbs., and since the average I.H.P. throughout the day amounted to 51.4, the coal used came to 5.3 per I.H.P., and 8.4 per E.H.P. per hour. If the plant had been run up to its full capacity, these figures would have been considerably reduced. As the cars ran 98 miles per day, the electrical energy per car mile did not exceed .82 horse-power hour, and one point incidentally noticed in taking volt readings on the line demonstrated the fact that the curves consumed more power than the grades.

About a year ago, Dr. Louis Bell made some tests on the Sprague road at Lafayette, Ind., and showed that the average efficiency was but 25 per cent., 37 per cent. would thus show a considerable advance in the direction of economy of power. Probably this record will be beaten at no distant date.

### THE LIVERPOOL ELECTRIC RAILWAY.

IN a few months there will be opened in Liverpool the overhead railway worked by electricity, which will occupy the proud position of being the first of its kind attempted in England. Last year a few Liverpool merchants met together to discuss the advisability of erecting a railway which would meet the wants of a rapidly-growing traffic. As a result, it was decided to commence the erection of an overhead railway worked entirely by electricity. It was not until the close of the year, however, that operations were fairly commenced. Now the work is being pushed on with great rapidity, and many of the girders are fixed in their places.

The railway, when completed, will consist of a wrought iron viaduct about six-and-a-half miles in length. Columns, composed of two channels and rivetted plates, support the superstructure. Stations are to be placed every half mile, at the points where the population lies thickly, from thence any place on the line will be reached in a few minutes. It is the intention of the company to charge very low fares so that the line may become popular; seeing that it will traverse a working district, this is perhaps necessary, for the revenue will probably be obtained from the lower class fares. The structure will certainly be the finest of its kind, and, as a viaduct, is the longest in the world.

The exact system of electrical propulsion is not yet defined, but there is sufficient guarantee as to the soundness of the technical work when it is mentioned that Sir Douglas Fox and Mr. J. H. Greathead are the engineers.

### HIGH SPEED IN ENGINES FOR ELECTRIC LIGHTING.

By ROBERT H. THURSTON, Director of Sibley College,\*  
Cornell University.

JUST a century ago, the "perfected" steam engine of James Watt had fairly conquered its place as a motor and as the great source of power for the growing industries of the world. Although Watt was not "the inventor of the steam engine," as he has been so often and so generally denominated; and although Newcomen and Cawley were its inventors, if we consider the steam engine as a train of mechanism, and not the old eolipile forms, as the germ of the modern machine; Watt, as the great improver and introducer of the engine, deserves all the honour that later generations have accorded him. The invention of the details of the modern engine was sufficient to entitle him to all

this, even had the machine done vastly less for the race than it has actually accomplished; but the benefit conferred was largely through the action of secondary and resultant developments. The wonderful expansion of the world's industries during the intervening century has been very largely, if not mainly, due to the provision, by Watt and his contemporaries and successors, of a powerful, convenient, economical and manageable source of power. The most striking phenomenon of the century, to the social and the political economist, has been this enormous development of a thousand new industries, of many thousands of new products of industry, and the extraordinary diversification of the skilled vocations of mankind. All this is to be recognised as consequent, very largely, upon the production by the great inventor of a suitable source of energy and power.

Since the days of Watt, there has been no industrial development even approximately as important as the now familiar and almost matter-of-course introduction and extension of the various applications of the power of steam through the intermediary of the electric current as its strong and far-reaching right arm. The growth of steam engineering during the last decade or more has been almost as great and as wonderful as during the earlier days of the development of the Watt engine. The use of the electric light and of electric power transmission, as in the use of motors and on street railways, and the many minor applications of electricity have compelled the expansion of many old lines of business most remarkably, and have accomplished even more remarkable things in the institution of new kinds of production. The glass-blower has been called upon to produce innumerable new forms, and to resort to numberless new and ingenious processes, to meet the exacting demands of the engineer; the worker in brass and in bronze, in fine iron work and in all departments of light tool-work, has been called upon to modify and to improve his methods, and to invent and apply a thousand new devices to the purposes of this latest of all the departments of engineering.

The maker of wire has been forced to seek the finest and purest copper, and to draw it into wire, harder, stronger, and in greater lengths, than it was ever before supposed possible to secure; new kinds of insulation, new systems of support and of preservation, have come into use, each improvement bringing after it a long train of minor or accessory inventions, discoveries, and improvements. Innumerable new forms of dynamo-electric machines, each specially and precisely adapted to a certain prescribed purpose, generators and motors of once unimagined perfection and efficiency; with, for each one of them, a host of little improvements and inventions in detail, have set the world agog with their work, have made the engineer wonder at their ingenuity, and have puzzled even the man of science and the professional electrician by the delicacy and subtlety of their theory, and by the variety and singular characteristics of their interacting currents and forces.

Finally, the steam engine itself has been given new forms to meet the requirements of this imperative new master. We propose briefly to consider the latest modifications of the engine, giving a concise and untechnical account of its special peculiarities, and the principles of its construction and application, as dictated by the new purposes to which it is sought to apply it.

There are two principal characteristics that distinguish the machinery employed for electrical distribution of energy from most other kinds of apparatus driven by the steam engine. The speed of rotation is unusually high, and the regularity of its motion, to insure satisfactory results, must be made extraordinarily perfect. To these two essentials all other considerations are subsidiary. In the various forms of machinery employed in the arts, outside this department, the first demand of the prime mover is generally economy of operation, and the exactness of its motion is a secondary, though often important, desideratum. In the most exacting work, that of cotton machinery producing fine goods, it has been thought that the regulation of

\* *Electrical World.*

the engine driving it should be made sufficiently perfect to keep the fluctuations, with usual variations of loads, within about one per cent. of the mean and within a total range of two per cent.; but, in electric lighting machinery, the range considered allowable is oftener half these figures, and some makers guarantee that the fluctuation shall be imperceptible, from full load to no load. The usual speed of the main line shafting in mills and in shops is rarely above 200 turns per minute, while, in the dynamo, the range is from about 1,000 on those of moderate size and of special types, up to 2,500 and 3,000 in extreme cases; while some are constructed to turn very much faster than the latter, even. The engine demanded of the trade for these latter purposes, therefore, must be capable of regulation to within perhaps one-half the range of the older types, and must be fitted to couple directly to machinery having five or ten times the speed of rotation of ordinary mill machinery. This demand, exacting as it is and seemingly impossible to meet, as it would have been thought not many years ago, has been satisfactorily fulfilled by a number of inventors and constructors.

The difficulties to be encountered in the attempt to comply with such conditions can hardly be realised by those unfamiliar with the steam-engine and its development. It was at once evident that the speed of rotation must be increased, and the ideas of Charles T. Porter, who had, as early as 1860, shown that speed is an element of economy, and had begun to exploit a "high-speed" engine, seeking economy in that manner, were recognised as elements of the new form of engine. In the days of Watt, the speed of rotation had rarely, even with small engines, exceeded 50 revolutions per minute; and Mr. Corliss considered that a speed of 75 revolutions was about as high as his tripping mechanism would ordinarily allow; but Porter went up at once to 200, and the Corliss engine is now sometimes driven at over 100 revolutions per minute. The modern high-speed engine goes far above these figures, however, and 300 revolutions is thought a very fair, but not radical, limit. In a few cases, as in engines of Ericsson and others built for special applications, this speed has risen to as high as 1,000, and even, with very short strokes of piston, experimentally to over 2,000.

Some of the conditions of success in the attempt to solve this great problem are sufficiently evident.\* The obviously essential high speed of rotation of such engines can only be attained by simplifying the construction of the machine just as far as practicable, and by discarding the "trip cut-off" and adopting some "positive motion" valve gear. But the trip was considered the vital element in the regulating mechanism of the older engines, as it allowed the governor to do its work without introducing irregularities in its action through resistances coming from the valve motion. Porter adopted a "positive" and then secured good regulation by use of the powerful loaded governor, in the form now so well known by his own name. Harnell and Guthrie, the inventors of the device in England, and Hoadley, the first to use it in this country, by adopting the now almost universally employed "shaft governor," gave to all later makers the means of solving this problem most satisfactorily, enabling them to use the simplest possible valve gear and yet to obtain a good distribution of steam and the most perfect regulation at the same time—conditions formerly considered absolutely incompatible.

It is practicable to make the "detachable" valve gear operative up to speeds even exceeding 100 revolutions per minute; the shaft governor is adapted to velocities of 200 turns and upward; the higher the better. At 300 revolutions a minute, a common speed with this class of machine, it is possible to regulate, by nice adjustment, to within a range of one-half of one per cent. This has been attained in engines tested by the writer, and may be attained by careful manipulation of the best high-speed engines of almost any well-known makers. This solves the second of the prime requi-

sites—the first from the point of view of application, perhaps—that of exact regulation. No system of electric lighting can be satisfactory in which the fluctuation of speed of engine can be observed at the lamp, in its varying intensity. Such fluctuation cannot be perceived where restricted to a fraction of one per cent., nor can it practically interfere with good work when kept well under two per cent., the once accepted limit.

Economy comes in as a third requirement of the new type of engine. The older "simple" engines were expected to give the horse-power on an expenditure of not more than three pounds of good coal per hour, if non-condensing, and about two pounds if condensing; which corresponded to about twenty-five or seven pounds of steam for the first, and perhaps twenty pounds for the second class, with the best modern boilers, economisers, and heaters. But the older types of engine had a great advantage in their admirable systems of valve gearing which gave an equally excellent steam distribution; the separate steam and exhaust valves, separated ports, and quick cut-off all conspiring to enable the engineer to secure the closest possible approximation to the perfect ideal which is essential to maximum efficiency. The use of a single valve, in the high-speed engine, restricts him very seriously, and compels a certain loss of efficiency. From 30 to 50 per cent. more steam was thus at first used in these engines. Good proportions of valve and of gearing, amply high speed of rotation—itsself an element of economy—and practically frictionless and "isochronous" governors were brought out; but the machine still remained a less economical heat engine than the older type, and in most instances, seriously so. The source of this waste and the methods of its prevention were promptly made the subjects of investigation, and the wonderful inventive faculty of the American engineer was set at work to devise improvements.

The cause of waste was very quickly detected in the large amount of "internal condensation" or "cylinder condensation," as it has come to be called, which was consequent upon the high heat-conducting power of the metal of which the cylinder is composed, and the exaggeration of this loss which comes from the increased proportion of surface exposed to weight of steam passed through the engine, as sizes are diminished. The increased speed of engine had diminished its size for a given power, and this had, in turn, with the less effective steam distribution, produced a large percentage of waste. The amount of this loss varies, in ordinary good practice, from about 25 or 30 per cent. in an engine of about 200 I.H.P., to 40 or 50 per cent. with engines of 50 H.P. of the same make, and to 60 or 70 per cent. in engines of from 1 to 5 H.P.\* The remedies previously found effective in the prevention of waste were, however, well understood, and were promptly put into practice by the more enterprising builders. These are three in number: 1. Increasing the work of the engine in such manner that the amount of condensation in the unit of time being given, its proportion to the quantity of steam used in the engine in the same time should be reduced. 2. Superheating the steam, thus reducing its capacity for wasting heat in the engine. 3. Compounding the engine so that the waste of the one cylinder might be utilised in supplying the demand due to waste in the succeeding cylinder.

The first of these methods had been found effective, but the new engine was precluded from resort to this expedient from the fact that it was already constructed for as high speed as was found practically safe and satisfactory. The second device was known to be effective; but, while every builder endeavoured to secure dry steam, with more or less success and without meeting with serious embarrassment, the attempt to use superheated steam had been shown, by many years of experience, to be invariably attended with more or less risk to boilers and engine, and with considerably enhanced cost of maintenance. On the

\* Stationary Engines for Electric Lighting. By R. H. Thurston. New York: J. Wiley and Sons. 1890. (New edition.)

\* Philosophy of the Compound Engine; Trans. Am. Society of Mechanical Engineers, 1889; Journal Franklin Institute, December, 1889.

whole, superheating had never become a successful and accepted method of increasing economy, though well known to be in theory and in practice a most efficient means of reducing these internal wastes. A half century of experimental use, under all known conditions, had not given it permanent place among the standard expedients for securing maximum economy of steam and of fuel, even though endorsed by the highest of European authorities, M. Hirn. A few great designers and builders, as Corliss and Leavitt in this country, and Cowper and a few others in Great Britain and on the continent of Europe, had, in special cases—usually in steam pumping engines—made good use of the device; but these instances were rare, and the system was, and is, but slowly gaining ground.

Compounding, on the other hand, had been practiced from the days of Hornblower, the rival of Watt. At first entirely unsuccessful, the gradual rise of steam pressures, the gradual increase of the ratio of expansion, and the continually increasing demand for economy in use of fuel and of steam, gave this system a stronger hold as the years went by, and it at last became, a generation ago, a somewhat common method of construction of large engines for important work, and has now become the universal system in marine engineering, and in some departments of stationary engine building, as in pumping engines and the finer class of mill engines of large power. It was not quite understood, however, until recently, by the average practitioner, what were the real causes of its efficiency, and it was not known whether it would pay to employ it in small engines. This last doubt was promptly removed upon trying it, and the "high speed compound engine" is rapidly becoming the standard engine for its special field of work. It was found that the total gain in the best constructions, due to compounding, amounted to something like one-third on engines of large power, and often to one-half with the smaller sizes. This made the difference between success and failure, in many cases, and with a handsome margin on the right side. Nearly all builders promptly took up the system, after the first experimenters had gone ahead.

So far as now known, there are but two ways in which further improvements can be effected. The speed is at a limit beyond which it is expected to go but slowly as methods of construction are improved, and as the attendants become accustomed to management of the new engine; the regulation is as near perfection in the best engines as is either desired or expected; and simplicity of construction can hardly be carried further; indeed, the symptoms are rather that we may see a reaction in the direction of a multi-valve distribution in some cases.

The economical use of steam is still far from that indicated by theory as the ultimate. The engine above referred to demanding from 25 to 70 lbs. of steam per H.P. per hour, as actually built in the various sizes specified, should, if the ideal conditions could be attained, give its power at the rate of less than 18 lbs. The best engines built to-day, of any type and of highest duty, have an ideal expenditure of about 8 or 9 lbs. of steam per H.P. hour, while they actually employ from 13 lbs. upward. The two ways in which these losses, of a third or more, can be further reduced, so far as now known, are increasing the temperature, and, perhaps, the pressure of the steam used, and the production of a non-conducting and non-radiating surface within the cylinder of the engine.

Superheating the steam was shown by Hirn to be the best and most philosophical method, provided it could be made practicable from the constructor's point of view. This has not yet been generally practiced, but it is not improbable that it may be done with good design and construction of the superheating apparatus and proper management of the engine. Its use would render the jacket superfluous, as it is known that the latter has no appreciable effect where the steam is kept dry in the cylinder. No wastes are left that it can affect. It would substitute for the disadvantages of the jacket, as a matter of construction, those of the superheating system. The latter have formerly been the

greater; but it does not follow that they will continue to be so. A good superheater, and a good cylinder lubricating system for high temperatures, would accomplish this end. These should certainly be within reach of the inventor and constructor.

The securing of non-conductivity of the internal heat-wasting surfaces of the cylinder would not seem absolutely beyond our reach. A century ago, Smeaton, the greatest engineer of his day, in part accomplished this result by the use of a sheathing of wood on his pistons and cylinder-heads. This cannot be done with the high pressures and temperatures of steam usual to-day; but other plans may prove feasible. Mr. C. E. Emery, many years ago, tried enamelling these surfaces and with enough success to show that the idea is a good one; though the enamels and coverings then available were not suitable for this purpose. The writer has found a method patented by him some time since similarly effective and possibly practicable, and doubtless other inventors will turn their attention to the problem, ultimately with complete success.\*

Could a material be found of sufficient strength and a good non-conductor, of which the steam cylinder could be made, this result would be reached, and the efficiency of fluid of the ideal engine would be practically attained.

Like the best engines of other types, the modern high-speed engine now seems to have been brought, in its best forms, to so perfect a condition that the range for further improvement is probably very narrow, and the gain still to be made must come slowly and painfully. In regulation and in simplicity of construction, in speed of rotation and in general adaptation to its special work, it is comparatively satisfactory. The further improvement must be in economy of its operation and maintenance. Greater efficiency of the working fluid will be gained, as in all other heat engines, by increasing the temperature of the steam; higher efficiency of the engine as a machine will follow more effective ways of reducing engine friction; but the compounding of the engine must be taken as the last large economical step in its improvement.

The problems now arising in its application are those which come to the engineer in all departments of his work. He must decide what efficiency he can afford to pay for in increased cost of engine; what size of engine he should adopt for a given amount of work; what size of "unit" of power he may best adopt in dividing up the work, if he is to divide it at all, among several engines, and what each subdivision of power should measure. In general, it is now well understood that the engine should be given a lower ratio of expansion than was formerly supposed economical under specified conditions.† The ratio should rarely, probably, be greater than three or four in simple non-condensing engines, and at less than 100 pounds pressure, or greater than six or seven in simple condensing engines. Compounding enables the engineer to design his engine with a view to expansion down to a terminal pressure—in the latter case of, perhaps, 10 pounds—economically.

The unit of power adopted is made the largest at which the engine can be continuously employed in its regular duties, and for some hours together. Every case, and especially in electric lighting, compels the designer to study the problem from many points of view, and to compute probable expenditures and minima of costs for a variety of possible arrangements,

\* My plan consists in dissolving the iron from the surface of the parts exposed to the action of steam, as the faces of the piston, the interior of the heads and the ports, by the use of acid, thus leaving a thin covering of reduced conductivity; which surface is then, if desired, filled with a still better non-conductor, as the resin of a drying oil, with which it may be saturated. The experiments of Prof. E. C. Carpenter and of Mr. P. M. Chamberlain, indicate that this may effect a saving of a large fraction of the now seemingly unavoidable interior wastes.—*Trans. Am. Society of Civil Engineers*, 1890 (*Cresson meeting*).

† For a study of this subject in somewhat wide relations, see papers on "The Several Efficiencies of the Steam Engine," *Trans. Am. Society Mechanical Engineers*, 1882, and *Journal Franklin Inst.*, 1882.

before he can finally safely decide just what system to employ or what type of engine is likely to prove best for the intended establishment and plant. Mr. Field's work at the Edison station in Brooklyn, and that of Mr. Henthorn in Providence, are good examples of this problem, carefully worked out, while the plans of the West End Company in Boston, and many of those produced by Mr. Sprague, illustrate the solution of similar problems in street railway work.

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### OBITUARY.

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**SAX, JULIUS, M.S.A., M.I.E.E.** Born in 1824, in Sagarre, Russia.—Mr. Sax was educated at Königsburg, and went to Hamburg in the year 1845, where he was apprenticed to the late Mr. Filby, optical instrument maker, of that town. Having served his apprenticeship, he went to Berlin, where he entered the telegraph establishment of Messrs. Siemens and Halske. He came to London in 1851, and worked with Mr. L. Oertling for four years, after which he started in business on his own account for the manufacture of instruments. Mr. Sax was employed by the late Prof. Graham, at that time Master of the Royal Mint, to construct automaton and other balances for use in the Mint. At the Great International Exhibition of 1862 he exhibited bullion and chemical balances, and obtain a prize medal for excellence of workmanship and accuracy. These balances were, on recommendation of Prof. Graham, purchased by the Government for the Mint of Hong-Kong. In 1863 Mr. Sax turned his attention to domestic telegraphy, &c., and in 1864 took out patents for a metallic fire alarm button, which would act as an ordinary call as well as a fire alarm; also indicators to be used with same and for other purposes. In 1869 Mr. Sax invented a form of magneto A B C telegraph (patented); in 1870 an improved mechanical recorder (patented); in 1872 an electric billiard marker (patented); in 1881 an electro-magnetic telephone (patented); an electric water gauge (patented); an electric tell-tale clock for watchmen, with a fire indicator combined; an electric vane; automatic system of electric call bells for fire stations, &c. (exclusively adopted by the Metropolitan Board of Works for all the stations of the Metropolitan Fire Brigade in London); a system of cell calls for police stations, prisons, &c., as prepared for and adopted by the Commissioners of the Metropolitan Police for use at all stations under their control; also an improved apparatus especially adapted for communicating between drivers and passengers in vehicles, &c. (patented); an electric apparatus for checking cash takings (patented); a perfected form of automatic fire alarm (patented). Mr. Sax has also made several improvements from time to time in electric bells and appliances for various purposes, and has been awarded eight prize medals for excellence of manufacture, &c. Death took place on the 21st August, 1890, at his residence, 108, Great Russell Street, Bloomsbury, London.

The business of electrical engineer and electric light contractor will be carried on by his sons, at 7, Ridgmount Street, Store Street, W.C.

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**Pay Station Telephones.**—An American contemporary states that a trial of the new automatic recording telephone system is to be had in Brooklyn, N.Y., by the New York and New Jersey Telephone Company. The new device, which is simply on the drop-a-nickel-in-the-slot plan, is to be adopted at pay stations. When a person wishes to telephone at a distance, on ringing up central from the pay station he will be told to place the proper amount in the slot. He will not be connected with the office he wishes to telephone to until he does so.

### NOTES.

**A New Lamp.**—A new all night lamp has been placed before the American public, which contains but one set of carbon holders. The novel feature of the lamp consists in the use of two carbons, held above in a clamp of peculiar design, and a third beneath of special size and shape.

**Church Lighting in America.**—The first church lighted by electricity in America is a new Catholic church at Westboro.

**Investments in Electricity.**—It is said that \$300,000,000 are invested in electrical undertakings in America.

**Variation of Carbon Resistance.**—The contribution on page 249, from Mr. Tanner, who sent us such an interesting communication last week, is another example of the truth of the old saw that there is nothing new under the sun. It is clear that Munck showed very conclusively the variability of the resistance of carbon under pressure, a discovery which has been claimed for others of later date.

**Okonite.**—The New York *Electrical Engineer* of the 20th inst. contains an illustrated description of the Passaic, N.J., factory of the Okonite Company. Water-power is utilised for driving the machinery, but this economical motor will not, we imagine, be available in the English branch works, which are said to be planned after the American establishment, which turns out daily an enormous quantity of insulated wire.

**Electric Coal Mining Machinery.**—Mr. Foree Bain, of Chicago, has devoted much attention to this subject, and has recently patented a complete system of coal mining by electrically-operated machinery, which consists of an under-cutting machine with an overhead drill for drilling a hole in which to place the explosive charge. The hole is drilled and the under-cut made simultaneously by the same motor. In good coal, Mr. Bain's machine will cut a slot 3 feet wide, 4 inches high, and 6 feet under, within three minutes.

**Prison Lighting.**—The Western Electric Company has just completed the installation of 1,100 lamps at the House of Correction, Chicago. Not only had the malicious propensities of the prisoners to be provided for, but in dealing with thick walls and steel plates, difficulties in the way of construction were met with to a degree not usual in electric light fitting. The hygienic conditions now obtained are said to have had a marked influence for good upon the spirits of those incarcerated.

**Strike in America.**—The *employés* of the Westinghouse Electric Company at Pittsburg struck, on August 11th, for shorter hours. 1,200 men are thus thrown out of work.

**Fires Caused by Electricity.**—A Dalziel cablegram says:—It is stated that the fire losses at Boston, U.S., during the past year have been four times greater than in any year since 1872. To electricity alone is attributed the loss of nearly £200,000 worth of property during the last twelve months.

**Electric Drilling Machines.**—The Brooklyn Navy Yard has adopted drilling machines worked by electromotors. It is stated that the form is very compact and portable, and a great saving of time is obtained in consequence of their employment.

**Lighting of Leamington.**—As a means of supplying a never-failing subject for argument and discussion, the electric light at Leamington has proved a distinct success. The trouble now appears to be as to whether the light given is up to standard or not.

**Man Wants but Little, &c.**—A strike of engineers occurred on the White Line Electric Road at Dayton, O., for an advance of \$2 per day, and the removal of the recently appointed manager who was engaged to promote better discipline. The strikers grounded the wires, and refused to allow the cars to be run back to the power shed. We should think that the rise demanded should read per week, although an American exchange gives the item as above.

**Electric Transmission of Power.**—When shall we be able to boast of supplying current to electric motors in workshops on anything like even a moderate scale? In New York alone this is done in small units to the extent of nearly 1,500 H.P., and it is expected that in another year the supply will be doubled.

**Proposed Electric Lighting at Weybridge.**—The Laing, Wharton and Down Construction Syndicate, Limited, having decided to apply to the Board of Trade for a provisional order, enabling them to light the parish of Weybridge by electricity, Mr. Kite, solicitor to the syndicate, and Mr. Rutherford, engineer, attended a meeting of the Chertsey Rural Sanitary Authority last week, for the purpose of explaining the scheme. It was pointed out that the syndicate was already carrying out the electric lighting of the town of Weybridge, but the area now proposed would be more extensive than the district already lighted. In order to obviate the objection to overhead wires, the syndicate was endeavouring to arrange for underground mains, for which, however, it would be necessary to obtain the consent of the local authority. The syndicate would ask for a period of two years in which to arrange for the carrying into execution of this feature of their scheme. After some discussion the authority consented to the provisional order, subject to the overhead wires being removed within two years.

**Southampton Corporation and the Electric Light.**—Mr. James T. Hamilton, secretary of the Southampton Electric Light and Power Company, Limited, writing on the subject of the recent negotiations with the Corporation of Southampton, for the purchase of the licence acquired by them, states that the corporation first approached the company, and that the offer of concession was made with reluctance. If the directors had foreseen the waste of time and inconvenience which has been occasioned by the delay of the company in coming to a decision, the offer would never have been made.

**Electric Etching.**—The *Papier Zeitung*, of Berlin, announces that an important discovery has been lately made in the processes of etching and photogravure. The drawing is traced on a plate of zinc by either an artist or by photography, with any suitable etching ground. This plate, backed with asphaltum, is laid in a bath of dilute acid. It is then put in circuit with a dynamo, the other pole being placed in the acid. On the current passing, the acid attacks the metal with extraordinary rapidity. A few minutes are sufficient to bite the plate, the depth of the etching being under easy control.

**Electric Lighting in Spain.**—The Huelva Gas Company, whose headquarters are at Glasgow, has applied for powers to light the town by electricity. Public opinion is so decidedly against electrical monopolies, that the local authorities have consented to grant the petition only under the condition that the gas company gives up all claims as to priority, &c., and is willing to enter into competition with other electric lighting companies.

**The "Peral."**—Coincident with the notice that a new Italian submarine boat has undergone successful trials, it is reported that the Spanish submarine boat, the *Peral*, about which the Spanish journals indulged in premature rejoicings, has been abandoned, having proved a complete failure.

**Private Lighting on a Large Scale.**—Mr. Rockefeller of the American Standard Oil Trust, is said to have spent \$150,000 in electric illumination of his park and grounds on the Hudson River.

**Cable Testing.**—The incident in our last issue, connected with cable testing, which might be termed a new development of the "Hall effect," ought not to be without its advantages. We have often had occasion to draw attention to the tendency of the electrical engineers of the present day to ignore the experiences of old timers in the telegraphic world, which, perhaps, for the future will be deemed worthy of more consideration.

**Gay-Lussac.**—A statue to Gay-Lussac, by Millet, was inaugurated at Limoges on the 11th. Gay-Lussac was a member of the Academie, and at one time collaborator with Arago and Ampère. He was also "reporter" to the Academic Commission, to whom much of the modern theory of lightning conductors is due. He died in 1850, just after he had commenced to devote particular attention to electric telegraphy. According to one of his biographers, he remarked at the time that it was extremely annoying to have to go just as the fun was commencing; or, in his own words: "Il est véritablement fâcheux de s'en aller, car voilà que cela commence à devenir drôle."

**Alternating Current Experiment.**—The *India Rubber World* says the experiment was recently tried of sending an alternating current of 1,000 volts pressure through the submarine cable which connects the electrically lighted buoy off Robbin's Reef, New York harbour. The experiment was made to see if the cable would stand the stress without breaking down or developing a fault, and the result was entirely successful as far as the cable was concerned. There was no leakage and no injury to the cable. This cable is insulated with gutta percha and was made by the Bishop Gutta Percha Company. The same company also manufactured the cables which carry current for lighting the six buoys in Gedney's Channel.

**Electricity on Wigan Tramways.**—The Chairman of the Wigan Tramway Company, after visiting the electrical works of the North Metropolitan Tramway at Canning Town, has presented a report to his co-directors, which states that the system employed would not work well in Wigan, as it could not be relied on. The report complains that the information given in regard to depreciation was scanty.

**Death of an American Telegraphist.**—Mr. Jephtha H. Wade, one of the pioneers of American telegraphs, died a few days ago at Cleveland. At a time when the financial position of telegraph companies was low, Mr. Wade's company was earning good returns. He constructed the first line west of Buffalo, and covered the whole of Ohio and Illinois with his lines. The well-known "Wade insulator" was invented by him. He leaves a fortune of about five million dollars.

**Messrs. Drake and Gorham.**—We understand that Messrs. Drake and Gorham have found it necessary, owing to the steady increase of their business, to double the size of their existing offices and stores.

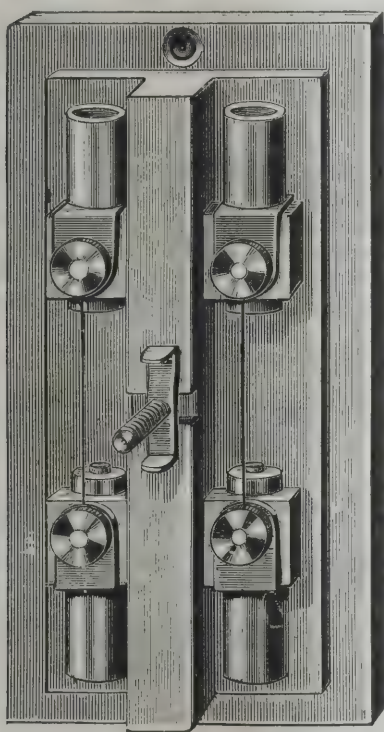
**Exportation of Para Rubber.**—During the first six months of 1890, says the *India Rubber World*, the United States absorbed 60 per cent. of the total exportations from Pará and Manáos, and about 70 per cent. of the shipments from Pará alone. A comparison of the quality of rubber imported by the United States, and by European countries from Pará, is shown in this table:—

	United States.	Europe.	Total.
Fina (fine) ... ..	5,750,716	4,541,919	10,292,635
Entrefina (medium) ...	1,140,757	877,263	2,018,020
Sernamby (coarse) ...	3,483,646	1,569,673	5,053,319
Caucho ... ..	702,831	353,014	1,055,845
Totals ... ..	11,077,950	7,341,868	18,419,818

**Elmore Shares.**—During the last fortnight a large rise has taken place in the price of Elmore shares, which are at present nearly £7. We also hear that negotiations are pending for the sale of several of the Foreign patents, the price of the Foreign company's shares being now nearly £9 per £5 share.

**The Stella Lamp.**—It seems that this lamp, a description of which appears on another page, is an old friend in a new guise. Mr. Desmond Fitzgerald could probably claim an intimate relationship with the Star which has suddenly appeared in the French Academy of Sciences.

**Binswanger's Patent Improved "H. I." Cut-Outs.**—Authorities on electric lighting have repeatedly dwelt upon the fact that the insulation resistance of electric light circuits suffer more from the fittings, switches, cut-outs, &c., used in the circuit, than from any other cause. In such cases, wire of a resistance of 300 or 600 megohms or more per mile has been used, and the leakage is traced entirely to the surface leakage of the china or slate at the back of the fittings. With a view to remedying these serious defects, the General Electric Company, Limited, has introduced a system of china fittings in which such leakage of the current is said



to be rendered impossible. The accompanying illustration shows a double-pole cut-out fitted in accordance with this patented system. The china is divided by a vertical wall, having four china blocks at its sides. To these china blocks are fitted the terminals for the wire, as also the screws for the cut-out. No screws or metal work appear at the back, and thus the leakage of current is obviated. This cut-out also has the advantage over those generally used that the fuse itself can be readily replaced. We understand that other fittings, such as switches, wall-plugs, ceiling roses, &c., are being manufactured by this company upon the same principle.

**The High Road to Success.**—The Brush Electrical Engineering Company, Limited, has entered into a contract with the London Road Car Company for the supply of 60 omnibuses for horse traction. These omnibuses will be constructed at the Brush Company's Falcon Works, Loughborough, where large extensions have been made to enable the company to cope with increasing demand for their steam engines, trams and omnibuses for electric or other traction, rolling stock, and electrical machinery, and apparatus of every description.

**Electricity and Advertising.**—Messrs. Pyke and Harris are adapting the use of vacuum tubes, in conjunction with Messrs. Pyke and Barnett's high-tension transformers, to the purposes of advertising, under the impression that letters or designs scintillating with the soft light of electric glow cannot fail to attract attention as much by their beauty as by their singular and entirely novel appearance.

**The New Spanish Cables.**—With regard to these cables, referred to in our issue of last week, the *Daily Telegraph* of August 25th contains the following announcement:—"The Foreign Office has issued the following: The Spanish Minister of the Interior, by a notice dated the 18th inst., has invited tenders for the construction and laying of telegraphic cables between Spain and the Spanish possessions on the north coast of Africa and to Tangier. Seven sections, of a total length of 332 miles, will be required. The maximum payment to the contractor will not exceed about £160 per mile. These tenders are to be addressed, in sealed covers, to the Director of Posts and Telegraphs, Telegraphic Department, No. 18, Calle de Claudio Coello, Madrid, and must be sent in within 30 days from the 18th inst. The conditions (in Spanish) may be seen at the Commercial Department of the Foreign Office, London, between the hours of eleven and five."

**Exhibition at Palermo.**—A National Exhibition will be held at Palermo next year. The committee has resolved to organise an electrical section in order to show the progress recently made in the various applications of electricity. It is proposed to make a larger display than those at the Milan and Turin exhibitions. The reasons why rapid development is taking place in Italy are the absence of gas works in many towns, the lack of a sufficient supply of coal, and the abundance of natural water power.

**Cable Laying.**—A very interesting article on cable laying appears in the *Cornhill Magazine* for September, a copy of which has been sent to us. It is not difficult to guess the quarter from whence it comes, and to those who desire to become acquainted, after half an hour's pleasant reading, with most of the operations connected with girdling the earth, we cordially recommend the paper.

**The Tory Island Cable.**—At noon, on August the 26th, the Duke and Duchess of Abercorn inaugurated the new signal and telegraph station on Tory Island. On approaching the island in the steamer *Thistle*, the Duchess threw overboard a floating box containing a number of telegrams, among them one addressed to the Queen, expressing congratulations on the establishment of telegraphic communication with the most westerly portion of Ireland.

**Probable Electric Lighting at Sheerness.**—The Sheerness Local Board of Health is considering the advisability of adopting the electric light for the town in place of gas, and has given instructions to their surveyor, Mr. W. W. Copland, to supply them, at their next meeting, with information on the subject.

**The Infant Dynamo.**—A memorandum from Messrs. Page and Miles, of Brighton, informs us that they have recently completed an electric light installation at Tudor House, Burgess Hill, the machine employed being an Austin "Infant" dynamo, 200 watts, shunt-wound, driven by a two-man gas engine, E.P.S. accumulators being used to regulate the current.

**Rashleigh Phipps and Dawson.**—Church lighting is making progress. Messrs. Rashleigh Phipps and Dawson have just received the order for a complete installation for the church of St. John the Divine, Kennington. The Royal Standard Music Hall, and St. Martin's-in-the-Fields Free Public Library, are also in the hands of the same firm.

**Personal.**—We referred in our issue of August 15th to the resignation by Mr. A. R. Bennett of his post of general manager to the National Telephone Company, Limited. We understand that differences with the directors was the cause. Since the amalgamation, last year, the operations of the extended National Company, which has nothing in common with the old National except the name, have been chiefly directed by gentlemen who were directors of the old United Telephone Company which worked London, and of the old Lancashire and Cheshire Company. Mr. Bennett, who had previously been unable to agree with the policy of the new board on several important points, determined, towards the end of July, on an event of an extraordinary nature occurring which showed cordial co-operation in the future to be hopeless, to sever his connection with the company at the earliest possible date—October 31st.

We understand that Mr. F. G. Thomas, of the Manchester Edison-Swan Company, Limited, has resigned his appointment as storekeeper of that company, and has left this country for Australia, where he will join the Williamson Electric Light Company of Sydney.

**The Bermudas-Halifax Cable.**—Messrs. Henley's telegraph cable ship *Westmeath*, lately engaged in the laying of the Bermuda-Halifax section, returned to the Thames on the 19th inst., having successfully completed the laying of the cable from Halifax, Nova Scotia, to the Bermudas. The expedition left the Thames on the 23rd May last, so that the whole work has been accomplished (including the guarantee period of 30 days) within three months. Eight soundings were taken near Bermuda in the main route of the cable, which showed a regular increase in depth from 24 to 1,240 fathoms, the steepest gradient found being about 1 in 4. Soundings taken on the Halifax side for the purpose of defining the slope of the bottom from the deep water up to the edge of the flat, which extends for nearly 100 miles outside Halifax, showed a regular decrease from 1,089 to 118 fathoms. The carrying out of this work reflects the greatest credit on Messrs. Henley's staff, it being well known that the laying of this cable presented exceptional difficulties, in fact, the strongest doubts have been expressed by authorities as to the possibility of laying such a cable successfully. We understand that the same vessel has been chartered by Henley's Telegraph Company for the laying, in the West Indies, of those cables which will form an extension southward of the system owned by the Société Française des Télégraphes Sous-Marins. As our readers are probably aware, the cables already laid on behalf of this company are:—

Aguadores (Cuba) to Caimanera (Cuba) ...	50 N.M.
Caimanera (Cuba) to Mole-St.-Nicolas (Hayti) ...	126 "
Mole-St.-Nicolas (Hayti) to Puerto Plata (St. Domingo) ...	188 "
St. Domingo (St. Domingo) to Curaçoa ...	453 "
Curaçoa to La Guayra (Venezuela) ...	163 "
	980 N.M.

**Newspaper Enterprise.**—The *Times* newspaper spent over £6,000 in telegraphing day-by-day the news of the revolution in Buenos Ayres.

**Electric Light Wanted in the Bermudas.**—A writer to a New York daily states that there are no electric lights on the islands, but that the principal inhabitants "want them badly." He mentions a dozen persons who would go to a heavy expense in order to have the electric light.

#### NEW COMPANIES REGISTERED.

**United Flexible Metallic Tubing Company, Limited.**—Capital, £75,000 in £10 shares. Objects: To amalgamate the Flexible Metallic Tubing Company, Limited,

and the Belgian and Colonial Flexible Metallic Tubing Company, Limited, and to carry on the business of mechanical engineers, electrical engineers and metallurgists. Signatories (with 1 share each): Claude Scott, 15, Arkwright Road, N.W.; R. Henderson, C.E., 8, Draper's Gardens; R. T. Hewlett, M.R.C.S., 28, Keppel Street, W.C.; A. H. Bacon, 30, Bridge Avenue, Hammersmith; J. W. Hewlett, 105, Bennerley Road, Wandsworth Common; S. Wade, 76, Santee Street, Clapham Common; J. D. Jones, 5, Ryde Terrace, Stockwell. The first directors are F. Walton, 4, Portugal Street, W.C.; G. Marsham, Maidstone; A. J. Thornton, 36, Rosary Gardens, S.W.; qualification, £250 in shares or stock; remuneration, chairman £200 per annum, each director £100 per annum. Registered 20th inst. by R. Hewlett, 31, Essex Street.

**Lamp Manufacturing Company, Limited.**—Capital, £16,000 divided into 1,000 preference shares of £10 each, 3,000 ordinary, and 3,000 deferred shares of £1 each. Objects: To adopt an agreement with the Redsdale Railway Lamp and Lighting Company, Limited, and its liquidator, Mr. Edward Cecil Moore. To manufacture lamps of all kinds, and apparatus for the consumption and supply of gas, oil, and electricity. To carry on business as mechanical, gas, and electrical engineers. To produce and supply gas, oil, electricity, or electrical currents or force, for light, heat, motive power, or force. Signatories (with 1 ordinary share each): W. W. Paine, 14, St. Helen's Place; J. J. Collins, 45, City Road; P. E. Chalhon, 18, Saltoun Road, Brixton; C. R. Pearson, 2, Balfour Terrace, Leytonstone; J. E. Wood, Dexter House, East Dulwich; R. Sutton Clarke, 132, Westbourne Terrace; C. J. Harper, 39, Leighton Grove, N.W. The signatories are to appoint the first directors; qualification, £50 in shares; remuneration, chairman, £3 3s.; each director £2 2s. for every meeting attended. Registered 26th inst. by Paine, Son and Pollock, 14, St. Helen's Place, E.C.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Vaughan-Sherrin Electrical Engineering Company, Limited.**—An agreement of 11th inst. provides for the purchase by the company of the following letters patent from John Vaughan-Sherrin, of 19, Duncan Terrace, Islington, N., viz.:—No. 15,730, 1887; 20, 1888; 2,666, 1888; 5,390, 1888; 12,455, 1888; 13,473; 10,647, 1889. Patents applied for:—17,831, 1889; 4,767, 1890. Foreign patents:—19,2907 (French), 1888; 83,228 (Belgian), 1888. The purchase consideration is £3,000 in cash, fully-paid founders' shares, and fully-paid ordinary shares, equal to the number otherwise allotted, so that the vendor and his nominees shall hold one-half of the shares of the company.

The registered office of this company is at 48, Eagle Wharf Road, Hoxton.

**Northern Electric Wire and Cable Manufacturing Company, Limited.**—An order of the Chancery Division of the High Court of Justice, dated 17th ult. and filed 18th inst., directs the striking out of the name of Edward William Hall, of Park House, Bradford, from the register of shareholders, as a holder of 160 shares. It is also ordered that the sum of £80 paid by him upon his application for shares be forfeited, together with interest thereon at the rate of 4 per cent. per annum from 4th July, 1889, to the date of repayment, and also the costs of his application to the Court, to be taxed by the taxing master.

The annual return of this company is made up to the 4th March. The nominal capital is £20,000, divided into 660 fully-paid up vendors' shares and 3,340 ordinary shares of £5 each. Upon the latter £1 10s. per share has been called, the calls paid amounting to £945 10s., and unpaid to £17 10s. The sum of £80 has been paid upon 160 shares forfeited since the return of the 12th November, 1889.

**Baxters, Limited** (general mechanical, marine and electrical engineers).—At an extraordinary general meeting of the members of this company, held at the registered offices, Sandiacre, near Nottingham, on the 15th ult., it was resolved that the directors may, notwithstanding any rule of law or equity to the contrary, contract on behalf of the company for the purchase from four of their number, viz.: S. Pryer Baxter, Frederick Baxter, A. N. Baxter, and C. H. Baxter, the goodwill and assets of their business at Sandiacre, at the price of £19,950, and which purchase may date from 1st June last. The resolution was confirmed on the 31st ult., and duly filed 1st inst.

**Beales, Limited** (confectionery and electricity).—At an extraordinary general meeting of this company, held at 370, Holloway Road, on the 14th ult., it was resolved to wind up voluntarily, Mr. H. S. Shipton, of Ellendale, Crescent Road, Crouch End, being appointed liquidator. The resolution was confirmed 31st ult., and duly filed 2nd inst.

**Head, Wrightson and Company, Limited** (engineers and bridge and pier builders, and electricians).—An agreement of 24th June, filed 2nd ult., provides for the purchase of the business of this firm, carried on at South Shields. The purchase consideration is £310,000, payable £240,005 in cash, and the residue in fully paid shares.

**John Wright and Company, Limited** (gas, electrical and general engineers).—An agreement of 26th June, filed 11th inst., provides for the purchase of the business of the firm of John Wright & Co., of the Essex Works, Aston Junction, Birmingham, for £85,183, payable £49,183 in cash, and the residue by the allotment of 100 debentures of £100 each, 2,600 preference shares of £5 each, and 2,600 ordinary shares of £5 each.

**Elmore's Wire Manufacturing Company, Limited.**—The following resolution, passed at an extraordinary general meeting, held at Cannon Street Hotel on the 14th ult., was confirmed at a meeting held at 20, Bucklersbury, on the 6th inst., and was duly filed on the 18th inst., viz.:—"That the following clause be substituted for Clause 80 of the articles of association: 'The company may make contracts with any of the directors upon such terms as the directors shall think fit, and a director shall not, by reason of the fiduciary relation subsisting between him and the company, be accountable for any profits made by him in respect of any such contract, nor, subject to the following proviso, in respect of any other contract made with the company in the profits of which he participates, or in which he is otherwise interested; provided that the fact of his being so interested therein, and the nature of his interest, be fully and fairly disclosed by him at the meeting of directors at which the contract is determined on, if his interest then exists, or in any other case at the first meeting of the directors after the acquisition of his interests; but, in the case of contracts with companies or firms of which any director of the company is a member, it shall not be necessary to disclose more than the fact of such membership, provided always that in no case shall such director so interested vote, or, if he does vote, his vote shall not be counted.'"

**Elmore's Patent Copper-Depositing Company, Limited.**—The annual return of this company, made up to the 11th August, was filed on the 18th inst. The nominal capital is £200,000 in £2 shares; 70,000 shares are taken up, and of these 23,300 are considered as fully paid up. Upon 46,700 shares the full amount has been called and paid, the paid up capital thus being £93,400. The sum of £7 18s. has been received upon 15 shares forfeited.

**Edison and Swan United Electric Light Company, Limited.**—The annual return of this company, made up to the 13th inst., was filed on the 21st inst. The nominal capital is £1,000,000, divided into 150,000 "A" and 50,000 "B" shares, of £5 each. The shares taken up are 89,261 "A," upon which 10s. per share has been

called, 17,139 "A," considered as fully paid, 23,564 "B," considered as fully paid. The calls paid amount to £223,152 10s.

**Plymouth and District Pulsion Telephone Company, Limited.**—An agreement of 13th inst., filed 20th inst., provides for the purchase by the company from the Primary Sydicate, Limited, of a licence to use the letters patent No. 8,457, dated 9th June, 1888, granted to Lemuel Mellett for improvements in mechanical telephones. The purchase consideration is £3,100, payable £100 in founders' shares and £3,000 in ordinary shares, all fully paid.

**Sheffield Telephone Exchange and Electric Light Company, Limited.**—The annual return of this company, made up to the 20th inst., was filed on the 28th inst. The nominal capital is £60,000 in £10 shares, the whole of which are taken up. Upon 923 shares the sum of £8 per share has been called. There has been called on 3,077 shares an aggregate sum of £10,770, being the balance due on the said shares after deducting the £7,692 considered as calls paid. The calls paid amount to £17,988, and unpaid to £166, and £33,846 is considered as paid upon 5,077 shares.

**City of Westminster Electrical Syndicate, Limited.**—The annual return of this company, made up to the 13th inst., was filed on the 20th inst. The nominal capital is £20,000, divided into 10,000 shares of £1 each, and 1,000 shares of £10 each. The whole of the £1 shares have been taken up, and the full amount has been paid thereon.

**Parker's Electric Wire Corporation, Limited.**—A meeting of this company was held on the 12th inst., when an account was given as to the manner in which the winding up of the company has been conducted, and its property disposed of.

**Consolidated Telephone Construction and Maintenance Company, Limited.**—The annual return of this company, made up to the 12th June, was filed on the 20th inst. The nominal capital is £307,545, divided into 75,000 6 per cent. preference shares of £1 each, 224,850 ordinary shares of 14s. each, and 75,150 ordinary shares of £1 each. The shares taken up are 25,000 preference and 224,850 ordinary shares. Upon each preference share £1 has been paid, and upon each ordinary share 14s. The calls paid amount to £182,395.

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## CITY NOTES.

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**The West Metropolitan Tramways Company.**—At the meeting of this company, held this week, the chairman, Mr. E. H. Bayley, in the course of his remarks on the position of the company, referred to the action of the various local authorities through whose district the company's line ran, and quoted from the remarks from Mr. Webb, their solicitor, at the last meeting on the question of electrical traction. Negotiations had been in progress in respect to this matter for several months, but eventually the electrical company withdrew their proposal. It was satisfactory, however, that fresh negotiations were in progress with another electrical company, who offered to undertake the work on advantageous terms as soon as the local authorities should have given their sanction. He moved the adoption of the report. Mr. J. W. Greig seconded, and his motion was carried. The proceedings terminated with a vote of thanks to the chairman.

**The Electric Construction Corporation, Limited.**—The Committee of the Stock Exchange has ordered shares Nos. 101 to 45,100 of the corporation, to be quoted in the official list.

**The Petroleum Engine Company, Limited.**—A meeting of shareholders was held at the company's offices, 23, Queen Victoria Street, E.C. The proceedings were not open to the press.

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## TRAFFIC RECEIPTS.

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The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending August 22nd, were £5,121.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 22nd, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,99.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 21.)	Closing Quotation. (August 28.)	Business done during week ending August 28, 1890.	
£.					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	97 — 100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50½ — 51½	50½ — 51½	50¾	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	87 — 88	87½ — 88½	88	87½
2,725,420	Do. do. Deferred	Stock	14½ — 15½	15½ — 15½	15½	14½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12½	11½ — 12½	12	11½
99,000	Do. do. 5 p. c. Bonds	100	100 — 102	100 — 102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107	103	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 2	1½ — 2	1½	...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2	1½	...
\$7,216,000	Commercial Cable, Capital Stock	\$100	103 — 105	102 — 104		
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	10 — 11	10 — 11		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	54 — 5½	54 — 5½		
16,000	Cuba Telegraph, Limited	10	12½ — 13 xd	12½ — 13		
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½ xd	16½ — 17½	17½	...
12,931	Direct Spanish Telegraph, Limited (£4 only paid)	5	3½ — 4	3½ — 4		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,716	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½	13½ — 14½	14½	13½
70,000	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	15
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109		
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	106 — 109	106 — 109	106	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½	14 — 14½	14½	14½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102		
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106	103 — 106		
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	103 — 106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	100 — 103	100 — 103		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	...	7½ — 8½		
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	6 — 6½	6½ — 7½	7½	6½
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 (£3 only paid)	5	2 — 2½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	8½ — 9½	9½	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15½	14½ — 15½	15½	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16	15½ — 16	15½	...
40,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103	100 — 103		
250,000	Do. do. (issue of 1883)	100	106 — 109	106 — 109		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	12 — 13	12 — 13		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½	4½	4½
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18½ — 19½		
200,000	Do. do. 4½ p. c. Deb., 1896	100	102 — 104	102 — 104		
17,000	Indo-European Telegraph, Limited	25	37 — 39	37 — 39		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. 6 p. c. Debentures	100	107 — 110	107 — 110		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4 — 4½	4 — 4½		
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4½ — 5	4½ — 5	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½	12½	...
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	4 — 8	4 — 8		
19,000	Reuter's, Limited	8	7½ — 8½	7½ — 8½		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	4 — ½	4 — ...		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3		
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117		
78,949	Swan United Electric Light, Limited (£3½ only paid)	5	5 — 5½	5 — 5½	5½	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	43
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	100½	...
55,000	United River Plate Telephone, Limited	5	3½ — 4½	3½ — 4½		
146,000	Do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10		
300,000	Do. do. 5 p. c. Debentures	100	100 — 103	100 — 103	102	101½
30,000	West Coast of America Telegraph, Limited	10	3 — 5	3 — 4	3½	3½
150,000	Do. do. 8 p. c. Debs, repay. 1902	100	106 — 110	103 — 108	105½	...
64,572	Western and Brazilian Telegraph, Limited	15	11½ — 11½	11½ — 11½	11½	11½
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7½	6½ — 7½		
26,986	Do. do. do. 5 p. c. Deferred	7½	4½ — 5½	4½ — 5½	5½	4½
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106		
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 — 104	101 — 104		
88,321	West India and Panama Telegraph, Limited	10	2½ — 3	2½ — 3	3	2½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 11½	11½ — 11½	11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	13 — 14	13 — 14		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 — 101	99 — 101		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 1½	1½ — 1½		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½ — 7½. — Elmore Copper Depositing Priorities, 7 — 7½. — Elmore Wire, ½ dis — par. — House-to-House Company (£5 paid), 5 — 5½. — International Okonite, Ordinary of £10 (£4 paid), 3½ — 4½. — London Electric Supply Corporation, Ordinary (£5 paid), 1½ — 2½. — Manchester Edison and Swan Company, £9 (£1 paid), 11/- — 13/-.

THE SANITARY ASPECTS OF ELECTRIC LIGHTING.\*

By W. H. PREECE, F.R.S.

THE chief tendency of modern legislation in our British Parliament is to improve the environments of the human frame, so that we may live, and move, and have our being with greater health to the individual, and greater prosperity to the nation. The cleanliness of dwellings, the drainage of towns, the removal of filth, the suppression of nuisances, have not only been specified but the inspection of the means to effect these objects, and of their results, are defined and insisted upon by Acts of Parliament. People often speak disrespectfully of our grandmotherly Government, but at least in this region of domestic legislation, the control it has exercised over the food we eat, the water we drink, the air we breathe, is of a true parental order, and deserves our unreserved admiration and respect. The Home Office and the Local Government Board act the part of a wise and economic head of the house to the nation, while each community has its own Local Board or Authority to carry out hygienic provisions, to enforce sanitary principles, to prevent infection, to stamp out disease, to sweeten labour, and to prolong life.

I contemplated at one time submitting an historical summary of these features of sanitary legislation during the present generation, but not only would the task be very onerous, but it would be so lengthy that I should have very little time left to discuss the question set before me—the sanitary aspects of electric lighting.

The propositions that I propose to submit and to demonstrate to you are these:—

1. That electricity and light being analogous and identical forms of energy, the former is naturally the proper source of artificial illumination.
2. That all other sources of artificial illumination being dependent on the absorption of oxygen, and resulting in the vitiation of air are injurious to health.
3. That the same authority which regulates the sanitation of our dwellings, and the supply of our food, should also control the purity of the air we breathe, and of the light we work by.

Light, however it be produced artificially, is simply the equivalent of work that has been done elsewhere. Whether it be by the combustion of tallow or oil, by the burning of coal or of gas, by the glowing of a fine wire, or the formation of the brilliant arc, energy has been expended somewhere, to be transferred and reproduced in some other place in the form of light. The great principle of the conservation of energy teaches us that the amount of energy in the universe is a fixed quantity, that it can be neither created nor destroyed, that it can only be transferred, and that any expenditure of energy—work done—anywhere is the equivalent of energy utilised somewhere else. The rate at which this energy is expended is called *power*, and the amount of power which we foolishly call a *horse-power*, and which we roughly imagine to be equivalent to the power exerted by a horse in drawing a load along a road, is competent to produce an amount of light which is very simply measured. Our standard of light is the light given by a No. 6 sperm candle, burning 120 grains per hour. Now the energy of one horse-power constantly expended will give by the aid of

Tallow ... ..	the light of 6 candles
Sperm ... ..	8.7 "
Oil... ..	9 "
Gas ... ..	13 "
Electric current—Glow	248 "
" Arc	1,492 "

The results to the air of these different modes of producing artificial illumination are well shown by the following table:—

Products of Combustion in developing 100 candles per hour.

Illuminant.	Quantity Consumed.	Carbonic Acid produced.	Water Vapour.	Heat.
	lbs.	cub. ft.	lb.	Calories.
Tallow .....	2.2	51.2	2.3	9,700
Sperm .....	1.7	41.3	2.0	7,960
Oil .....	1.3	33.6	1.8	7,200
Gas .....	56 cub. ft.	40.3	2.5	12,150
Electricity .....	(Coal) 2.2 lbs.	0	0	257

Thus we see how very much more efficient electricity is than any other agent for the production of light.

The great hygienic advantage of the electric light when illuminating our dwellings and our workshops, is not that it purifies the air, but that it prevents the air from being vitiated by the introduction into it of the products of combustion, such as carbonic acid, carbonic oxide, sulphurous oxide, &c.; it prevents the air from being weakened by the abstraction of oxygen, and it prevents it from having its temperature raised by undue radiation; and by throwing into it heated gases.

While legislation and the greatest possible stringent regula-

tions have been drawn up to prevent the adulteration of food and the poisoning of water, scarcely any attention has been devoted to the prevention of the admission of noxious gases and poisonous vapours into the air of our habitations. Carbonic oxide is a poison of the deadliest character, and gas jets are freely used which deliver copious discharges of this dangerous gas into the atmosphere of our rooms. If we were consistent in our legislation, we ought to forbid the use of any burner which thus poisons the air. A man at rest exhales 0.0424 cubic feet of carbonic acid gas (CO<sub>2</sub>) and 1189 cubic feet of air per pound weight per hour, while a gas jet burning 5 cubic feet of coal gas, exhales 4 cubic feet of CO<sub>2</sub>. The maximum proportion of CO<sub>2</sub> to air consistent with health is 6 volumes in 10,000, 10 volumes affect the heart, and 30 volumes produce headaches. Rheumatism, bronchitis, and other ailments proceed from higher proportions. In fact, 5 cubic feet of gas requires 8,000 cubic feet of pure air per hour to maintain it healthy. The electric light requires no such provision.

That the electric light is a powerful element of health is evidenced by the fact that those who use it not only feel all the better for its introduction, but their appetite increases, and their sleep improves, and the visits of the doctor are reduced in frequency. Workpeople work all the better, and absences from illness are far less frequent. In the Savings Bank in Queen Victoria Street, London, where 1,200 persons were employed, the absences from illness were so far reduced, that the extra labour gained paid for the electric light. In Liverpool and many other places the same result has been observed.

The influence of artificial light on the eyes has a very important sanitary bearing. Why is it that there is so much short-sightedness in the present day? Is it due to our mode of producing light? Some assert that the injury to the eyes is due to the heat rays and not the light rays. If that be so the electric light must be much less injurious than any other. On the other hand, no one can have experimented with arc lamps without having had his retina painfully affected, which leads one to think that the ultra-violet rays have some influence. No one has, however, ever complained of the influence of a steady glow lamp upon the eyes, and it is possible to read and to write for many hours by such a light without experiencing the least fatigue.

The electric current is not altogether free from being a cause of fire, and though its use is by no means very general, still it is used sufficiently to make itself felt as an element of danger in this respect. The following table shows the number of fires in London which can be traced to the different methods of lighting:—

	1887.	1888.	1889.	Total.
Lamps ... ..	245	205	257	707
Gas ... ..	188	197	209	594
Candles ... ..	142	113	136	391
Electricity ... ..	0	1	2	3

The progress of the electric light in our homes has been much more rapid in England than in any other country, but its employment for street-lighting, for shops and manufactories, has been infinitely more rapid and extensive in the United States than with us. In America the growth has been enormous. There are now 250,000 arc lamps, illuminating the public streets and shops, and 300,000,000 glow lamps in dwellings, stores, and workshops.

The following table shows the development of the Berlin Central Stations:—

Station.	Effective of Horse-Power.						When Completed.
	1864.	1887.	1886.	1887.	1888.	1889.	
Friedrichstrasse...	300	300	300	300	300	300	300
Markgrafenstrasse...	...	1000	1000	1000	2400	2400	3100
Mauerstrasse...	...	...	500	1250	1250	2950	4950
Spandauerstrasse...	...	...	...	...	...	2000	4000
Schiffbauerdamm...	...	...	...	...	...	1000	6000
Total ... ..	300	1300	1800	2550	3550	8650	18350
16 C.P. lamps, or equivalent ... ..	2500	4600	13229	24660	34750	...	...
Kilometres of cable ... ..	...	8.	10	15	25	75	...

The progress in England has been very much checked by inordinate speculation, and by terrible failures in some of the earlier work done. There is something very captivating in the practical applications of electricity, and something romantic in its mystery. The neophyte has rushed into it with remarkable fervour, and the lessons of failure have in consequence been very severe. The users of the light have also been paying heavily for the education and experience of amateur tradesmen and inexperienced contractors, and have neglected to avail themselves of the professional services of the experienced electrical engineer. People who would not build houses without the architect, nor construct bridges without the engineer, nor make their wills without the lawyer, rush wildly into the use of electricity without any professional assistance, where, above all things, experience and knowledge are essential to prevent disaster and disappointment. Large installations have been completed without specifica-

\* Abstract of paper read before the Sanitary Institute, Brighton, August 26th.

tions to guide the contractor, and without inspection to see that the work has been properly done. The user has paid violently for his temerity, and fires and accidents have been the result. The heavy price of wiring a rented house, and the expensive character of the fittings proposed, have deterred many from adopting the light, even when it is within their reach. Highly insulated wire is unfortunately expensive. All cheap wires are nasty and dangerous. There is nothing that becomes the electric light better than simplicity, and its effect is frequently marred by elaborate brass work. It possesses also most active and widespread opponents, both in oil and gas—opponents who have benefited by its introduction, and who are not slow to profit by its advance. The improvements in gas and oil lamps are as marked as the advancements in electric light, and as means of artificial illumination alone—that is as far as light-giving power is concerned—there is little choice between the three, but oil and gas cannot lose those elements of discomfort and ill-health which differentiate them from the cool and pure glow lamp.

A very important question arises for discussion. Legislation has slipped in to place the virtual control of the supply of electrical energy in the hands of the local authority of the district to be served. Is this supply to be the result of the capital of private enterprise, or is it to be effected by raising money on the security of the rates?

It is argued that the supply of electricity being a purely commercial undertaking, it should therefore be carried out by a limited liability company. The Acts of 1882 and 1888 do not encourage monopoly, but rather court competition, and competition attracts capital. Competition properly regulated and controlled secures economy in supply, and certainly enforces economy in working, while it encourages improvements, and induces perfection of apparatus and novelty in processes. These arguments are plausible, but are easily refuted by those who desire to uphold vested monopolies. Direct competition always means ultimately enhanced cost to the public, for the same public has to pay for double plant, and each competitor only gets half revenue.

The supply of light is in precisely the same category as the supply of water or the supply of gas, and the days have certainly passed when the public will tamely submit to the transference of their right to such vested interests as those of gas or water companies.

It is very easy to argue *pro* or *con* on each side. The local authority has to regard the security of traffic, the safety of person, the repression of crime, and the proper supervision of the premises of its ratepayers. It is the custodian of the public interests. It has to control the health, cleanliness, comfort, and beneficial sanitation of its habitable dwellings. It therefore must secure the best light, and if it can do this, and at the same time relieve the rates which are generally creeping up to dangerous dimensions, then its action would be wise and economical. But it would be entering into commercial rivalry with an active competitor—the gas companies; and its commercial control by such a shifting authority as a committee of a Town Council or of a Local Board, subject to the changes of political warfare—to the vagaries of press dictation, and to the fear of November elections—is a very doubtful proceeding. On the other hand, in many instances, such bodies have successfully dealt with the water question, the tramways, and even with the gas. In fact, one-third of the gas capital (21 millions) in this country is in the hands of 173 Local Authorities, and more than half a million of profits go to the reduction of rates.

Bradford has already grappled with the question. It has established a central station for the supply of the electric light. Brighton, St. Pancras, and Bristol are doing the same, and many other places are following suit. They are shying at the probability of handing over their districts to a speculative company, with a virtual though not a legal monopoly, to supply electrical energy for 42 years. Many corporations contemplate a middle course. They have obtained the power for themselves, but they have farmed for shorter terms the right of supply to private enterprise, which can do what they are afraid to do, viz., speculate and experiment. The Board of Trade has sanctioned and facilitated such a transfer of statutory rights.

It is surprising that gas administrations in England have not been more enterprising in developing electric lighting. In Vienna, Rome, and Stockholm the gas companies have established central stations, and the progress of the industry in these cities is very great. The proper function of gas is to supply heat, not light, and as a source of power it has a future more brilliant than its past. If it could be supplied as fuel it would remove the troubles of coal transit and storage, of ash and dust removal, of smoke and of stoking. It has even been shown that it is cheaper to convert coal into gas on the spot, and to use the gas as the source of power, than to apply the coal direct for the production of steam in boilers. The waste of energy in the use of coal is enormous. The energy contained in one pound of coal if burnt in one hour is theoretically sufficient to supply 5·6 horse-power for that hour. The best practical result yet obtained by the steam engine is scarcely one horse-power.

The electric light is unquestionably the light of the future. Its use is advancing with leaps and bounds. Not only is it naturally the proper source of light, but economically it must eventually supplant its rivals. When electrical energy is generally distributed through our towns, and its supply is continuous, and properly controlled, so that it is always within the reach of all; and when means can be devised to wire up houses as cheaply as they are now fitted for gas, everyone will take it, not alone for its beauty, but because it is, above all, a source of health and comfort.

## THE BERMUDA-HALIFAX CABLE.

THE following particulars of this cable may be of interest to our readers:—

The core is composed of seven copper wires stranded, weighing 120 lbs. per N.M., and of three coats of gutta percha, weighing 150 lbs. per N.M. The core is covered throughout with a serving of jute yarn, steeped in a preservative mixture and then whipped with 3-ply jute yarn.

The conductor resistance is stated to be 10·5 ohms per N.M., at a temperature of 75° Fahrenheit; the dielectric resistance after 24 hours' immersion in water at the temperature of 75° Fahrenheit, was to have been not less than 1,000 megohms after one minute's electrification.

In the deep sea type the core is sheathed with 16 galvanised iron wires, each ·099 of an inch in diameter; the outer covering consists of two coats of Russian hemp laid on in opposite directions, and three coats of bituminous compound. The weight of this type, wet in air, is about 1·8 tons per N.M. The sheathing of the light intermediate cable is composed of 12 galvanised iron wires, each ·165 of an inch diameter; the outer covering is the same as in the deep sea type. The weight of this type, wet in air, is about 3·5 tons per N.M. The core, in the heavy intermediate type, is sheathed with 12 galvanised iron wires, each ·220 of an inch diameter; outer covering same as before. This type weighs, wet in air, about 6 tons per N.M.

For the Bermuda shore end the core is first sheathed with 12 galvanised iron wires, each ·165 of an inch diameter, a sufficient serving of jute and compound is then laid on, and this is then covered with an outer sheathing of 12 strands of three wires each, each wire ·203 of an inch diameter. The external covering is the same as before. This type weighs about 19 tons, wet in air, per N.M.

According to the *Bermuda Royal Gazette*, the Halifax shore end is of a lighter description, having only one sheathing, and weighing only about 10 tons per N.M.

The *Westmeath*, a steamer chartered by Henley's Telegraph Company for the laying of the cable, is a vessel of some 4,500 tons. She left the Thames on May 23rd, carrying 874 N.M. of cable. She was under the command of Captain Stonehouse, the engineer-in-charge being Captain Stiffe, late of the Indian Marine. Mr. Peake, of the firm Clark, Forde and Taylor, represented the Halifax and Bermudas Cable Company.

The *Westmeath* anchored at Bermuda on the 6th June, and left on the 12th to sound along the route of cable, completing the soundings commenced by the *Challenger*. The vessel arrived at Halifax on June 16th. It is stated that the soundings were taken 100 miles apart, except near the land, where they were made at close intervals. The deepest water found is said to have been 2,820 fathoms, with a bottom temperature of 34·4° Fahrenheit. The laying was commenced from the Halifax end on the 25th June, arriving off Bermuda on the 30th, the final splice being made on the 7th July, some difficulty having been experienced in the laying of the shallow water portion, light draught vessels being employed for the purpose. The total length laid was, we understand, about 850 N.M.

The capital of the company is £120,000, in 4½ per cent. first mortgage debentures, and £50,000 in ordinary shares of £5 each. The English Government grants a subsidy of £8,100 per annum for 20 years.

It is stated that considerable traffic will be obtained between Bermuda and New York, and that some revenue will arise from ships which, it is hoped, may make the Bermudas a port of call. We presume that some business beyond that which may proceed from casual winter visitors from the States, or from an occasional vessel in distress, is anticipated. No doubt the cable is of importance as connecting two British naval stations, but this fact does not necessarily imply a paying investment.

## REVIEWS.

*Electric Light Fitting: A Handbook for Working Electrical Engineers.* By JOHN W. URQUHART. London: Crosby Lockwood and Son, 1890.

The volume before us is an attempt to state in the simplest language the precautions which should be adopted in installing the electric light, and to give information for the guidance of those who have to run the plant when installed. It is addressed to intelligent men who are engaged in the electrical industry, or being trained for it, special attention being given to the branches known as "fitting" or "wiring." As might be expected, the contents cover a somewhat extended area of practice, and a deal of information which may prove useful to the expert as well as to the working electrician is given. As a book justifying its pretensions it can be recommended, though in many instances we do not find ourselves in agreement with the author. At page 11, for example, the author is not at all clear regarding the reason for giving the brushes a lead, and does not seem to know that when a lead is given they are still almost at right angles to the lines of force, the latter being twisted, however, by the armature current. We should like to know the names of the electricians referred to who have made the calculations showing that machines without iron in their armatures require no lead. On page 32 the author refers to the pumping or pulsating of arc lights, and mentions that extinctions and rapid self re-lighting sometimes occur. This is unfortunately true, but Mr. Urquhart does not explain that the reason of this misbehaviour is mostly due to faulty proportion in the dynamo, which has to be carefully guarded against by those who manufacture closed coil arc machines. The author is a little behind the times in advocating the insulation of the armature core from the shaft. No good machines are made so now-a-days, nor is it necessary, even for the highest E.M.F. The remarks about the coupling of alternators in parallel are extremely weak, and the instructions to the attendant are not at all clear. Regarding the running of arc lamps in parallel, it is said, they "work very well when fitted with resistances or choking coils, as they are called." Here the author fails to distinguish between resistances and choking coils, two things which are essentially different in principle and construction. We should say the author's knowledge of arc lamps and their working has been derived mostly from books.

Coming to the question of loss between the dynamo and the lamps, a limit to this is set at 5 volts. In our opinion, this variation is far too much to allow, and  $2\frac{1}{2}$  volts would be nearer the mark. In talking of the series system of incandescence lighting, the author says that it is impracticable when carried beyond a few lamps, as a line of 50 lamps of 100 volts would call for 5,000 volts. Of course no engineer in his senses would for a series system use 100-volt lamps, so this argument is quite untenable. An alternator working direct on to lamps is said to be less liable to breaks-down than a direct current machine, as there is no commutator to get out of order, but surely the exciter commutator is as likely to go wrong as would be the commutator of the large machine if it were direct instead of alternating, so here we fail to see an advantage.

There are many more statements to which we take exception, but space will not permit us to notice them. Though there is much that might be objected to on the grounds of scientific inaccuracy, the book, on the whole, is well worth the perusal of the workman, for whom it is written. If we cannot have a practical work scientifically accurate, we must be content with the nearest approach to it we can get.

*The Labour Movement in America.* By RICHARD T. ELY, Ph.D. of Johns Hopkins University. London: William Heinemann.

Trades Unionism and Socialism have of late become such important factors in the economy of the world

that it is no longer prudent for any thinking man to ignore their existence and drift. Literature on these subjects is by no means scarce; almost every leader of working men has written articles, pamphlets and books thereon, and we find a chapter here and there in treatises on political economy, but most of these are somewhat biased, and therefore do not reveal the true state of affairs. Prof. Ely appears to have studied the labour questions from all points of view, and he is by no means a novice, having already written two books of a kindred nature, viz.: "French and German Socialism" and "The Past and the Present of Political Economy," besides numerous articles in American magazines.

In his preface the author addresses working men, expressing sympathy with many of their movements, not, however, without judicious qualifications: "Much that is done in the name of labour I regard with abhorrence. In the same way should the reader understand my admiration for the Knights of Labour. I believe it is a grand society, but I dissent from some of its principles, and from its course in some localities. Individual knights and individual assemblies have been guilty of outrageous conduct with reference to their employers, the general public, and their fellow workmen. Their deeds have sadly injured the cause of labour." Prof. Ely warns working men against violence: "Destruction of the property or lives of others cannot help you or enrich you. Your triumph can come only by peace. There is much that is bad in existing social arrangements, but there is also much that is good, and this good has been procured by struggles of centuries. With a full appreciation of all that is sad and disheartening in the condition of the masses, I believe that, on the whole, the lot of mankind was never a happier one than to-day." Again: "If your demands are right, if they are reasonable, then you will win, and hold your gain. The world will listen even to socialism, if properly presented. Educate, organise, wait."

The author then discusses with a masterly mind "Early American Communism, The Growth and present Condition of Labour Organisations in America, The Economic Value of Labour Organisations, The Educational Value and other Aspects of Labour Organisation; Co-operation, Modern Socialism, The Socialistic Labour Party, The Strength of Revolutionary Socialism—its Significance," and finally, "Remedies." There is also a copious appendix, setting forth the principles advocated by various associations and labour conventions.

We feel tempted to quote passages from every chapter. The book is full of interest, and it must prove equally instructive to employers, to *employés*, and to students of political economy. We are ever confronted with strikes, and wars between capital and labour. Prof. Ely suggests several remedies worthy of consideration.

#### VARYING THE FORCE OF AN ELECTRIC DISCHARGE BY DIFFERENTLY COMPRESSED CARBON POWDER DISCOVERED BY MUNCK, OF ROSENSCHOLD, IN 1835.

By A. M. TANNER.

It has generally been held that du Moncel first discovered the peculiar property which carbon and certain other semi-conductors have of varying their resistance when subjected to a change of pressure. Upon the advent of the Hughes microphone and Edison carbon telephone, the question of priority of discovery of the variable resistance of carbon with pressure was exhaustively discussed in the journals of that period, and the credit of prior discovery was awarded to du Moncel.

During the year 1887 I drew attention, in the *Electrical World*, to the fact that Beetz, in his experiments

made in the year 1861 to test the electrical conductivity of carbon, placed carbon powder or spongy platinum in a glass tube, and subjected it to variable pressure by piston-shaped electrodes in order to obtain a change of resistance. This same method was subsequently embodied in the well-known Clerac carbon rheostat, upon which Edison founded his first carbon telephone. In fact, it would appear that Edison had no knowledge of the earlier experiments of du Moncel, Beetz, and Clerac, when, according to Prescott's work, "The Speaking Telephone, A.D. 1879," he is quoted as saying that he applied to the telephone "the peculiar property which semi-conductors have of varying their resistance with pressure," a fact discovered by him while constructing rheostats in which were employed powdered carbon and plumbago in glass tubes.

I will now proceed to show that the prior discovery of the property that the electrical conductivity of carbon is varied by pressure, is due not to du Moncel, Beetz, Clerac, Edison, or others, but to the Swedish physicist Munck, of Rosenschöld, who published certain experiments on the capacity of solid bodies for conducting electricity in Poggendorff's "Annalen der Physik und Chemie" for 1835, Vol. XXXIV., p. 437. After describing the apparatus used in his experiments, such as a large Leyden jar, and electrometers of different capacity, and the action of electrostatic discharges upon various bodies, the author continued, on page 459, as follows, viz.: (Note.—I have endeavoured to translate the German as literally as possible)—

In order to ascertain how carbon powder, variably packed, will be affected by the action of the electrical discharges I placed the calcined carbon mass (obtained by calcining wood carbon in a closed crucible) very loose in the longest glass tube.

The discharge of 25° of the first electrometer was felt at a distance of 13 inches. A discharge of 25° of the second electrometer had no influence upon the conductivity; heavier discharges, however, of 35° to 40° of the quadrant electrometer increased the conductivity, so that the shock of a discharge of 11° was felt at the same distance. After this the carbon powder was taken out, but immediately placed again in the same tube, and moderately packed together. The degree of conductivity was now 20½°, and after strong discharges had been passed through the same, the shock was already felt at 17°. Thereupon the carbon powder was placed in the glass tube for the third time, and very strongly packed. The degree of conductivity was now raised to 33°. By the action of stronger discharges the conductivity was further increased, and the shock of the first electrometer was made perceptible at 16°.

On page 461 the author says that he is of opinion that the phenomenon of the increase of conductivity is due to the change of position, or displacement of the smallest particles or granules of carbon or other material operated upon.

It will readily be seen that Munck, of Rosenschöld, discovered the variation of electrical resistance that carbon powder will undergo when subjected to a change of pressure. It is true he did not use voltaic or current electricity, but discharged a Leyden jar through differently compressed granular or powdered carbon, and he found that the conductivity increased when the granules of carbon were brought in closer contact with each other. This is exactly the principle involved in that class of telephone, and other rheostats where compressible granular or powdered carbon is used.

### THE "STELLA" LAMP.

THE following is a translation of a note presented by M. le Comte de Gerson to the Académie des Sciences, and to which we referred last week in our "Notes":—

"The lamp, which is the result of investigations made by an English company, which numbers amongst its members some of the most eminent English savants,

has been tested at the Ecole des Mines, and, since, by the mining company at Anzin, in one of its mines the most infected with fire damp.

"The lamp weighs about 1,600 gr., and its illuminating capacity is about that of a candle. It is guaranteed to burn with perfect regularity for a period of 12 hours, but actually it possesses an effective capacity of 14 and even 16 hours' duration. It takes five hours to charge with a current of 1 ampère and 4 volts. It is composed of an accumulator, consisting of two ebonite cells, each of which contains five plates 75 mm. long, by 45 mm. wide, and so arranged as to be protected from exterior shocks. Two of the plates are composed of solid lead peroxide, known as *lithanode*; together they weigh 180 gr., and possess a capacity for useful work of 7 ampère hours. The three others are composed of spongy lead, maintained by a support which is extremely light, and offers a very feeble resistance and a high conductivity; practically it is never used. The more the lithanode is charged the better it becomes, and disunion of the plates never occurs. As there is no contact between the plates, no local action takes place in the accumulator when this is at rest. The total capacity of the accumulator is 28 watt-hours. Thus,

$$7 \text{ ampère-hours} \times 4 \text{ volts} = 28 \text{ watt-hours.}$$

"In ordinary mining, the incandescent lamp requires about 5 ampère-hours in 12 hours' lighting.

"The electrolyte used with the accumulator is sulphuric acid diluted, the specific density of which is 1.170.

"The exterior case is of galvanised steel, which is not liable to be rusted by damp. There is a space of about 60 mm. between this and the accumulator; it is padded with rubber, to avoid damage from sparks to the accumulator's ebonite case.

"A little below the centre of the anterior face of the lamp there is a small glass lens, behind which a small incandescent lamp is placed, which, being mounted upon a spring, is drawn into the lamp when the latter receives a shock through the breaking of the first glass. Above the lens there is a commutator, which enables the lamp to be lighted or extinguished at will, so that, in case of a falling in of the works in the rear of the workmen, they would be still in possession of a light for as many times 10 hours as they had lamps.

"The safety is absolute against any imprudence on the part of the miners. Lamps have been broken in gases much more explosive than fire-damp without an explosion. Moreover, the lamp is to be recommended for its simplicity, cheapness, and the duration of its lighting."

### THE INDUSTRIAL UTILISATION OF THE COUNTER-ELECTROMOTIVE FORCE OF SELF-INDUCTION.\*

By THOMAS D. LOCKWOOD.

It may as well be confessed at the outset that although my production has cost me considerable thought, it does not claim to advance any original ideas. Its claims to attention are based solely upon its merits as a chronicle. There seems to be among the modern race of electricians not a few who regard that species of counter-electromotive force which is the subject of this paper, as being the only species in the genus. While, of course, this view is erroneous, it is easily accounted for by the notorious fact that the American electrician, as a class, has little time to study. The fact, however, while it is indeed as I have termed it, "notorious," is still to be deplored; for it is certain that were electricians fully informed not only of the researches which took place before their own, together with the results of the said researches, whether these results took the form of success or failure, there would be much less valuable time wasted in supposed original research; there would be far fewer valueless inventions produced; and there would be a much smaller amount of subsequent vexations and useless litigation.

While counter-electromotive force, generally speaking, is a

\* A paper read before the general meeting of the American Institute of Electrical Engineers, Boston, Mass., May 21st, 1890.

genus; the counter-electromotive force of self-induction is a species, and while an illustration of this statement will no doubt to most of us be an operation something in the nature of carrying coals to Newcastle, or water to the Mississippi valley, I cannot believe that it will be a waste of time, since doubtless we have many members who have not fully considered the subject.

Consider for a moment a definition of electromotive force. What shall we say it is? It certainly is not a natural force like gravitation, and I do not think we can do better than concede that we call it a force, simply because it is convenient so to do; and define it as any agency tending to set up that form of motion or vibration which we call electricity; or, if you please, any agency tending to the manifestation of electricity.

We are constantly hearing that a current of electricity is the result of a difference of potential between two points connected by a conductor, but though this statement, through constant repetition, has come to be, as it were, "human nature's daily food," I am inclined to consider it as being after all but a mathematical way of saying that a current of electricity is the necessary result of an electromotive force provided with a closed conducting circuit. For it is the electromotive force which first determines the difference of potential, which therefore may be considered as being a kind of initial result. Following out this train of thought, it appears then that electromotive force is a function of the source or instrumentality which develops the current, and expresses the totality of difference of potential in the entire circuit; and while we may properly speak of the difference of potential, or fall of potential between any two points on the circuit, I think we can not with equal propriety speak of the E.M.F., in any other way than as something pertaining to the source.

And further consideration of the same idea shows the incorrectness of the popular phrase often used of late years even by many eminent and able electricians, "a current of so many volts," the electromotive force being in no sense, near or remote, an attribute of the current.

To run counter to anything is to run against it, to run in opposition to—to act oppositely; and so a "counter electromotive force" may be defined as any agency tending to develop a current of electricity in a circuit, opposite in direction to that of the current excited therein by the initial electromotive force.

A familiar instance is that of connecting up in an electric circuit a certain number of cells in opposition to a number of other cells. This constitutes a primary counter-electromotive force, and its inclusion in the circuit reduces the current in two ways; first, by reducing the acting electromotive force to a value equal only to the algebraic sum of two opposing forces; and, secondly, by adding internal resistance of the value of the cells added in opposition.

Another familiar illustration is found in that ingenious class of dynamo regulator which acts by causing the opposing brushes to creep around the commutator, and, according to the work which is being done in the external circuit, to include in the circuit (by increasing or decreasing the lead of the brushes), a greater or less number of armature coil sections exerting an electromotive force in opposition to the electromotive force which is developing the working current.

In these cases a utilisation is made of counter-electromotive forces deliberately organized for the purpose, but they are not counter-electromotive forces due to self-induction.

At a very early period in the history of voltaic electricity it was discovered that there was some deteriorating force at work in every voltaic battery which depreciated the current to a much greater extent than exhaustion of the liquids or consumption of the solid elements could account for; and, in 1801, Gautherot found\* in this phenomenon, which has foolishly been called "polarisation," the germ of the secondary cell. He discovered that wires of platinum or of silver which had been used to decompose salt water acquired a power of themselves, yielding a current when placed in acidulated water, and could cause muscular contractions of a frog's leg, and produce the galvanic test. And subsequently it was ascertained that the operation of a voltaic battery tended to coat the negative plate with hydrogen, which tended to set up a counter-electromotive force between the hydrogen and the surface of said plate, which thus reduced the available energy of the battery, and that this action could be transferred to the electrodes of the same battery, if placed in a separate decomposing cell, and there tended to form electrically opposed surfaces, which could themselves be used to develop a current in a direction opposite to that of the original current. As we all know, this operation, long regarded only as an unmitigated evil, is now utilised in the formation and operation of cells adapted for the electrical storage of energy.

The counter-electromotive force of self-induction distinct from the foregoing, is that discovered by Prof. Henry; and its most important use is that which has been mainly brought out in association with the employment of alternating or other currents for the purpose of regulation. By reason of the fact that this utilisation has proved to be overwhelmingly important, the electrical fraternity has partially lost sight of many earlier and contemporary instances of the useful employment of self-inductive electromotive force; which is indeed a close analogue in its character, mode of generation, and capabilities of use in regulation to that developed and utilised in the operation of electro-motors.

Firstly—I desire to point out that though Henry was the first to study and discuss self-induction, he was not the first to notice its effects.

Until quite recently I, together with nearly everyone else, had supposed that the earliest published notice of this phenomenon was Henry's account\* of his observation, published in 1832; but I have, in my researches on the subject, dug out the fact that this is not so. I find that an experimentalist, Vassali-Eandi by name, records that,† with a pole of 50 pairs, he found that the fluid passed along a copper wire plated with silver, 1,151 feet in length, in a time incommensurable; the shock in this case was three times as strong as that experienced by immediately touching the two extremities of the pile.

The above isolated statement of facts stands, I believe, alone, and there is no record that it led to further research.

Henry, on the contrary, perseveringly pursued, and made himself master of the subject, and the record of his original observation, brief though it is, details the appearance of a vivid spark on the breaking of a battery circuit, if a wire 30 or 40 feet in length be included in that circuit, shows that the effect is increased by coiling the insulated wire into a helix; and that the effect depends in some measure on the length and thickness of the wire. The note concludes with these remarkable words: "I can account for these phenomena only by supposing the long wire to become charged with electricity, which, by its reaction on itself, projects a spark when the connection is broken."

This, though brief, is then the first analytical notice of the electromotive force of self-induction, so long erroneously denominated after its result, the "extra current."

It is unfortunate that Prof. Henry did not for some time pursue the subject, and we do not hear from him again until March, 1835.

Meanwhile his great contemporary, Faraday, had taken it up, pursuant to an observation of one William Jenkin, and showed self-induction to be a corollary of his former masterly experimental researches in magneto-electro induction.

Faraday notes‡ the following points: "Self-induction exists in simple helices as well as in electro-magnets, though not to the same degree.

Helices are superior in developing induction to straight wires, and long wires to short ones.

Self-induction practically disappears when the conductor is permitted to inductively act upon a neighbouring closed circuit.

That the amount of self-induction depends on the length of wire exposed to inductive action.

An iron core within helices much exalts the action of self-induction.

The self-inductive effect depends not "upon a permanent state of the core, but on a change of state."

Henry now again takes the matter, and in a consecutive series of papers, practically runs it to earth.

§ In a paper of March, 1835, he gives more in detail, some of the conditions of the development of self-induction. A long wire is better than a short one; a helix better than a straight wire of equal length. He also describes a shocking coil, and also a deflagration coil of but one wire, in which self-induction is involved.

|| A little later he elucidates the origin and properties of self-induction, and records that some additional energy appeared when iron was used as a core, but not much, because his coils were flat, and not elongated helices. He ascribes all of these effects to dynamical induction, and shows that in a coil of a number of convolutions, the convolutions act inductively on each other, and inferentially that the energy of the self-induction is the sum of that of the different coils.

¶ In a third paper further experiments in self-induction or with the extra current, as it was then called, are discussed. We learn that the electromotive force of any self-induction coil within certain limits is dependent upon the length of the coil.

That the form of the coil has considerable influence on the intensity of the action. In the experiments of Dr. Faraday, a long cylindrical coil of thick copper wire inclosing a rod of soft iron was used.

This form produces the greatest effect when magnetic reaction is employed.

The "extra current" of self-induction developed in a coil is controllable by the presence of an immediately adjacent inde-

\* Silliman's American Journal of Science, July, 1832, Vol. XXII., pp. 403-8.

† Philosophical Magazine, Vol. XV., 1803; also Phil. Magazine, Vol. III., 4th series, 1852, p. 455.

‡ Experimental Researches in Electricity, Faraday, 1839, Vol. Ninth series, pp. 332-343, read before the Royal Society, January, 29th, 1835. A series of notes, "The Influence by Induction of an electric current on itself."

§ Journal of the Franklin Institute, March, 1835, Vol. XV., pp. 169-170. Silliman's American Journal of Science, July, 1836, Vol. XXVIII., pp. 327 and 331; and Scientific Writings of J. Henry, Washington, Vol. I., pp. 87-91.

|| Transactions American Phil. Soc., N. S., Vol. V., pp. 223-231, reprinted in Scientific Writings, J. Henry, Washington, 1886, Vol. I., pp. 92-100.

¶ Transactions of American Phil. Soc., Vol. VI., pp. 303-337, November 2nd, 1838. Silliman's American Journal of Science, March, 1840, Vol. XXXVIII., pp. 209-243. Scient. Writings of Joseph Henry, Washington, 1886, Vol. I., p. 108.

\* See Izarn's Manual du Galvanisme, Paris, 1804, and Phil. Mag., 1806, Vol. XXIV., p. 185.

pendent coil. It is energetic when the circuit of the adjacent coil is open, but absent when the adjacent circuit is closed.

Of course it is impossible in this paper even to indicate the many good things which are spread before the reader of the researches of both Faraday and Henry. They are well worth study, and in fact they laid a solid foundation for the work which is being done now.

Both discovery and invention are displayed in their work, much of which has only found its sphere of action within the last four years; for it is emphatically true, as has been said by Mr. W. H. Preece, "that though we are accustomed to hear that necessity is the mother of invention, the child is, as a matter of fact, often born before its parent."

As is frequently the case with electrical discovery, self-induction was for long recognised, that is for the most part, and by the generality of electricians only as an unwelcome guest whose parting was to be speeded.

It was manifested mainly by an undesirable spark appearing upon the break of electric circuits in telegraphic, scientific and medical apparatus, and tending to burn away, or oxidise, contact points; while in the case of the two wire induction coils its effect was to reduce the spark passing between the terminals of the secondary; and many have been the expedients, wise and otherwise, which were devised for its banishment. Many of these were patented, more were not, inasmuch as the fever for patenting everything from a solar system to a thought had not then come into fashion.

Examples of this class of expedient are respectively:—

British Patent, No. 12,772, September 20th, 1849, granted to those old heroes of electric lighting history, Staite and Petrie, which has for its 18th clause a mode of "preventing the spark when breaking contact in galvanic circuits. A thin platinum wire may still convey some portion of the current after the main circuit is broken, or a series of sufficiently long conductors may break contact one after the other." The preferred way, in plain English, was to connect a fine wire as a shunt round the break, and thus to furnish a closed circuit in which the self-induction circulated its current of breaking.

United States Patent, No. 33,269, granted to J. E. Smith, September 10th, 1861, for a means of preventing the spark between the local points of a relay on breaking the circuit—shunting the break by a wire having two terminals dipping into a bottle of water.

Moreover, as is well-known in the ordinary induction coil, the action is emphasised by shunting the primary break by a condenser, as first suggested by Fizeau.\*

This, as I shall point out later, is a real instance of the industrial utilisation of self-induction.

Other early investigators in this line reduced the spark of breaking the circuit, by wire shunts also.

Although, as I have stated, the recognitions of self-induction were mostly recognitions of an adversary, there were one or two early instances where the enemy was subjugated, and made to expend his energy usefully. The most notable instances of this are the single wire spark coils of Page and Callan,† which were made especially with a view to exalt the self-inductive effects, and with which metals were fused, and electrolytes were decomposed.

These were the forerunners of the spark coils used at the present day in electric gas lighting, and comprising a single long coil wound to a suitable length upon a long core of iron wires.

There can, however, be no doubt that the principal attempts to make useful the counter-electromotive force of self-induction, and likewise the principal successes achieved, have been in the line of controlling, regulating, or modifying the original, initiatory, or primary currents from which it has been developed.

I have compared this to the transposition of a given number of battery cells.

This analogy is however imperfect, since in cells of battery we may for the sake of argument regard the E.M.F. as being practically constant. Certainly they will in no sense regulate themselves in accordance with conditions automatically, but the inductive resistance *will* do this. For it is dependent for its efficiency as a generator upon the strength of current flowing through it. Therefore, if the current through it due to the impressed electromotive force from any reason falls, the counter-electromotive force will also diminish, and thus will permit a greater amount of the initial force to act; or, in other words, will permit the impressed energy to become more effective. Suppose we have in the main circuit of an alternating dynamo, supplying a number of incandescent lamps in bridges uniting its mains, an adjustable resistance; and suppose the inductive resistance, which we may also regard as a counter E.M.F. generator, to be initially adjusted, so that all of the lamps burn brightly; then within limits of considerable range the current will be kept steady, even though the applied E.M.F. fall or rise, or though the external resistance of the circuit be varied by lighting or extinguishing lamps.

For if lamps be extinguished and their branch circuits be opened, the external resistance rises and the current falls. It is true that the reduced current has not now so many branches to divide through, and that therefore self-regulation even without counter E.M.F. might be expected, but in systems of considerable magnitude it is not found to act practically, as well as it theoretically should. But here the useful effect of our self-induction regulation comes into play; and since the current acting upon the

regulator is lowered, it is caused to develop a counter E.M.F. of less value, and thus to oppose less energetically the applied E.M.F., which therefore is brought to a greater extent into action, to overcome the increased resistance, and to maintain the normal current for the remaining work. So, if the applied potential falls, the current in consequence falls with it, and the counter E.M.F. developed falls also, and enables more of the applied E.M.F. to come into action. And the converse is true, if the current in the circuit from any other cause rises. Such an appliance would be still more convenient in connection with an arrangement of arc lamps fed by alternating currents, and connected up in parallel circuit, since the resistance of arc lamps would constantly be changing.

This has been so prominently brought before us by its most modern employment, namely, by its well-nigh involuntary use in the distribution of electricity by means of alternating currents and transformers or converters, having their primaries connected in parallel between the two mains of the source; and by the inductive resistance regulating device, patented by John Hopkinson, in England, August 3rd, 1881, No. 3,362; and in the United States, November 5th, 1889, No. 414,541, that many persons have actually been led to believe that such use is really a new thing.

The employment in the regulation of electrical distribution of counter-electromotive forces set up by the working currents themselves, and proportioning themselves automatically to the work being done, is one of the most valuable and interesting features of modern electrical work; and, though such regulation requires to be supplemented by auxiliary arrangements, and though the belief of some that it could be attained absolutely without any waste has not been completely realised, still by availing ourselves of this feature we are enabled to control electricity with a facility and under conditions which otherwise would be unattainable.

The Hopkinson invention consisted in associating with an arc or glow electric light circuit employing alternating currents, a variable inductive resistance. This in one form was made by coiling a ribbon of thin sheet iron into a ring form, the different layers being separated by an insulating layer, and then by winding a number of coils of insulated wire on this ring, their adjacent ends being connected with plates between which contact plugs could be inserted, so that any number of the coils could be introduced or cut out from the circuit. Another form embodied the same principles, but had not a closed core. This form had a horse-shoe core made of an electro-magnet formed of layers of sheet iron insulated from each other. The legs of the core are surrounded with the coils, and the said core has an armature also made of insulated layers of sheet iron. In this form the armature is clamped down; but the regulability of the appliance is attained by moving the magnet core further into or withdrawing to a greater or less extent from the surrounding coils. The form first described is in the British patent shown as being included in circuit with the two mains of a dynamo; incandescent lamps being in cross bridges between the said mains while in another figure arc lamps are in parallel circuit with mains, an inductive resistance being included in each branch for each lamp, and acting as an equaliser.

The iron core closed on itself to form a complete magnetic ring in which the lines of force are concentrated through the coil, and forced to cut all convolutions when exposed to reversals; the laminations at right angles to the currents, acting to facilitate magnetic change, to diminish hysteresis, and to prevent the circulation of eddy currents; and the insulation of the said laminations aiding in the latter function, all tend to show that this is a very highly organised appliance, and is not only well adapted to produce a very high degree of self-induction, but combines most of the best arrangements tending to that end, and it is therefore not surprising that its invention and use made a strong impression upon the electrical mind, and caused a revival of the idea that regulation on these lines was capable of being accomplished, to use the words of the patent, "without wasting energy." Without materially wasting energy would perhaps be more strictly accurate, for by its use a small amount of actual resistance coil is enabled to do the work of a very much larger amount.

I have certainly no desire to detract from the great merit of this application, but an honest chronicler has no choice, and must say what has been done, and it must therefore be stated that inductive resistances and other self-induction appliances had long been used both experimentally and commercially; no doubt often with but an imperfect conception of their mode of operation.

\*Poggendorff's researches into the action of induction coils disclose a remarkable state of affairs for so early a date. These show that one induction coil was employed to send a current through the secondary helices of two others. The first coil thus acted as an alternating generator, and the two others as inductive resistances.

The primaries of two induction coils were connected in parallel and also in series at different times. When, to quote Poggendorff's own words, "two instruments (induction coils) A and B, were so combined that the current traversed the two primary coils one after the other, the induction coils (secondaries), however, were separated, and A was allowed to give sparks, whilst B remained unclosed and without a soft iron core; the

\* Comptes Rendus, Vol. XXXVI., p. 418, 1853.

† Sturgeons Annals, Vol. I., pp. 290-302.

\*Poggendorff's Annalen, Vol. XCIV., p. 2, and London and Edinburgh and Dublin Phil. Magazine, 1855, Vol. X., 4th series, pp. 136-137.

introduction of the latter into B, weakened the sparks of A, and the subsequent metallic closing of B reproduced their former strength."

The proper arrangement of induction coils is then discussed, and whether the primaries should be connected in series or in parallel circuit. It is shown that the latter way is the proper one, and why. Then the paper goes on to say; "With respect to the cause of these phenomena, it is no doubt to be sought in the extra or inner induction current. The outer induction current, which is produced by breaking the inducing current, has the same direction as the latter; whereas the extra current, which is at the same time excited in the induction wire, whose tendency is to weaken the first induction current, and the more so the stronger the extra current, which latter is especially strengthened by the soft iron core.

"Consequently, when the primary coils of A and B are connected one after the other, it is clear that the insertion of the soft iron core into that of B will strengthen the extra current in that of A, and therefore weaken the induction current of the latter instrument.

"By connecting the instruments side by side, a closed circle is at once formed by them, and the extra current produced by the insertion of the soft iron core into B acts against that in A, and may, therefore, when both are equal, completely neutralise it, when the outer induction current of A will necessarily be strengthened.

"Without the circle formed by this combination, i.e., in the wire leading back to the voltaic battery, the two extra currents act of course in the same direction, and strengthen one another, in consequence of which the sparks at the current breaker are still very active."

These considerations of Poggendorff show that even at this early period a great flash of light was thrown into the darkness, which hitherto had obscured the reactions of self-induction, and though we have largely failed to use that light until quite recently, this is chiefly attributable to the same oft-recurring reason, that there was really little call for it; hence it was soon hid under the bushel of the results of research on other subjects of more immediate interest.

The statement which I last quoted brings me again to the application by Fizeau of the condenser as a shunt to the vibratory brake, and to its operation.

\* As shown by Lord Rayleigh, the condenser operates by producing electrical oscillations, and in its action the spark at the contact breaker is greatly decreased, and the spark between the secondary terminals greatly magnified, because at the break the condenser is virtually an inductive reservoir, being an electrostatic shunt. And being an electrostatic shunt, the energy it momentarily absorbs is returned reversely to the primary circuit, just as in the discharge of a secondary cell, and increases the inductive variation in the secondary circuit during the brief period of time immediately after the break. And as the electromotive force in the secondary is thus exalted, it is not difficult to see why the condenser increases the sparking distance.

As early as December 6th, 1862, a patent for cable working, No. 3,453, was taken out by C. F. Varley, which describes the use of a self-induction resistance. This patent says: "A second circuit from the cable to the earth, independent of the receiving instrument, is formed by means of a resistance coil with a large iron core. It may be advisable to connect the cable to earth through an induction coil, consisting of a large bundle of iron wire, surrounded by a long length of fine wire, the action of which is as follows: On reversing the battery connections, the induction plates (condenser) and battery combined, send a short impulse into the cable, which divides; one portion into the cable, the other through the induction coil to the earth. At the first moment, the iron of the core opposes the passage of the current, consequently during the first instant of time nearly the whole force of the current is applied to the cable. As the iron becomes magnetised to its maximum, this opposition ceases, but the plates have been charged in the opposite direction, and there is no longer any current passing from them into the cable to maintain the magnetisation of the iron; the demagnetisation of which induces a current in the coil and discharges the cable. In this way each impulse is followed by a short impulse in the opposite direction. One of the figures of the patent shows that the wires of the core are made long, and are turned back on all sides over the wire of the coil, so as to entirely encase it. This feature was in conformity with a previous British patent, No. 3,059, of 1856. The arrangement, however, clearly shows a use of a self-induction coil as a current controller, and indicates the function of a large iron core.

We next find the counter E.M.F. of self-induction coming into use in connection with fast telegraph systems. Arrangements for its use are shown in the United States patents granted to Mr. Edison. These are, respectively, No. 135,531, of February 4th, 1873; No. 141,773, of August 12th, 1873; and No. 147,313, of February 10th, 1874.

The first and second disclose a shunt circuit, including an electro-magnet connected round the receiving instrument of a chemical telegraph. The first also shows a leak to earth from the line, which leak includes an electro-magnet. In both cases the object is to utilise the discharge current developed by the electro-magnet in the regulation of the operation, and to produce sharp and clear signals.

The third describes the use of electro-magnets in shunt circuits

round the transmitting and receiving instruments of an automatic telegraph system, and is said to be an improvement on the first. A number of electro-magnets are shown, and by means of a switch one or more of these may be introduced. In other words, the inductive resistance is here adjustable, and is operated by breaks, not by reversals.

British patent, No. 3,935, November 14th, 1874, to Alexander Melville Clark for a chemical copying telegraph, uses induction and other coils to clear a line by the self-inductive counter E.M.F. By the decrement or cessation of the impulse (as the patent states) the strongest depolarising effects are produced, and the line is successfully cleared.

Next come four other patents to Thos. A. Edison. These are U.S. patent, No. 163,243, of September 28th, 1875, for an automatic telegraph. This, as in the previous cases, employs an electro-magnetic shunt.

U.S. patent, No. 168,385, of October 5th, 1875, duplex telegraph. This is an excellent example of self-inductive regulation. The counter E.M.F. is developed from electro-magnets in a changing electric circuit, and the coils have cores closed on themselves.

The next two, No. 173,718, of February 22nd, 1876, for automatic telegraphy; and No. 178,221, May 30th, 1876, Duplex Telegraphy, involve no new principles, and are like the preceding ones.

\* Much information regarding the subject, and further examples of its practical application, can be found in a particularly able paper on "Shunts," read by William H. Preece, before the Society of Telegraph Engineers in 1887. The subject of the counter E.M.F. developed in electro-magnets is discussed, and the increase of the same, when the iron core is endless, is determined and pointed out; a good many instances of the practical uses of the self-induction shunt are described.

U.S. Patent, No. 207,724, of September 3rd, 1878, granted to Thos. A. Edison for a duplex telegraph, shows an electro-magnetic coil and closed magnetic circuit core placed in each branch of a Wheatstone bridge duplex telegraph, to counteract by its counter E.M.F. of self-induction the discharge of the electro-magnets in the bridge circuit. In Culley's Handbook of Practical Telegraphy, London, 1878, pp. 303 to 304, also pp. 305 and 411, the regulation of currents by inductive resistances is considered.

In the first instance, the counter E.M.F. of an adjustable series of electro-magnetic coils is used to delay the discharge of a condenser in a duplex system. This is closely analogous to the function of the Hopkinson device, and is very suggestive. The reference on page 305 states that "static discharge can be entirely compensated for by the use of an induction coil, or a series of electro-magnets, instead of a condenser."

U.S. Patent, No. 227,039, of April 27th, 1880, to Muirhead and Winter, for a quadruplex telegraph, describes electro-magnetic shunts for reversing keys and relays, which are to counteract, by their discharges, electrostatic retardation. The specification says: "The electro-magnets may be of the well-known closed horseshoe form, or they may consist of a single rod of soft iron, with flanges of soft iron, and a cylindrical casing of iron closing over the wire, and connecting magnetically flange with flange.

U.S. Patent, No. 231,904, September 7th, 1880, to Joseph E. Fenn, duplex telegraph, uses an electro-magnetic generator of counter E.M.F. in the line circuit to counteract effects of discharge. It is made with a closed magnetic circuit, a separate coil being on each leg of a multiple pole core; several of these poles are made with yokes, and the combined yokes can be made magnetically continuous or discontinuous at will by means of iron plugs, which can unite the different sections of core.

A book published in 1880, by Louis Schwendler, and entitled: "Instructions for testing telegraph lines, and the Technical Arrangements of Circuits," Vol. II., pp. 144-147, gives a description of an electro-magnetic shunt and its operation. It is made like an ordinary electro-magnet, but has an adjustable wedge-shaped armature in contact with the cores. This, of course, operates by utilising the counter E.M.F. of self-induction, which develops currents that circulate through the shunt, and sharpen the signals.

In telephony, also, as in other fast systems employing rhythmic currents, the counter E.M.F. has by no means been idle. As in telegraphy, our early acquaintance with it was an unpleasant one. Many of the earlier telephone lines connected with a number of stations, and at each station there was, of course, an electro-magnet to operate the call. In some cases this was a telegraph relay, and in other cases a bell magnet. But in either case it was found, as, indeed, might have been anticipated, that the telephone currents had a decided repugnance to pass through the intervening electro-magnets on their way from one station to the other. To quote the graphic words of one of the patentees of devices intended as remedies for this trouble, it was found that electro-magnets were, to a large extent, "opaque to telephone currents."

Of course this is due to self-induction. The resistance of the line or the magnet coils had little or nothing to do with it. The convolutions, however, had, since it is clear that the electromotive force of the self-induction was proportional within certain limits to the number of convolutions.

The same difficulty appeared also in exchange work, where between any two connected lines was interposed an annunciator, to give from either end station a disconnecting signal. Several

\* Phil. Mag., Vol. XXXIX., p. 428, et seq.

\* Journal of Society of Telegraph Engineers, London, 1877, pp. 40-69.

devices have been suggested for the removal of this difficulty, and some of them have been patented.

Elisha Gray shunts the several interposed magnets by condensers: *vide* United States Patent, 203,264, of May 7th, 1878.

F. W. Jones, attacking the same difficulty, shunts the interposed magnet by a non-inductive resistance controlled by the armature of the signalling magnet. See United States Patents, 238,399, of March 1st, 1881, and 238,912, of March 15th, 1881.

Other devices have also acted to shunt the bell or annunciator magnets in different ways; and still other suggestions have been to surround the iron core with a brass sleeve, or with a closed circuit consisting of one layer of insulated wire; but these last, while certainly reducing the retardation, reduce also the magnetic power of the appliance. And there is no remedy so effectual as the absence of the interposed electro-magnet.

The service rendered by self-induction in telephony, and that which still may be expected, fortunately will probably outweigh the ills which it introduces. In many switchboard installations for metallic circuits, the supervising telephones are looped or bridged across between the two conducting links which unite one of the two metallic circuits with the other, and their self-induction prevents a material loss of current. Where from some condition of the service, such, for example, as the requirement of supervising both metallic and earth return circuits at the same switchboard, it sometimes becomes necessary in bridging the telephones to attach an earth branch to the connecting link on one side of the instruments; in this case it has also been found necessary in practice to place coils containing iron cores on the other side of the earth branch, so that not only the resistance, but also the self-induction, may be balanced.

It has also been ascertained that many telephones can at different stations be placed across from one wire to the other of a metallic circuit, without any perceptible diminution of the effect at any one of them. This is one of the most important results of self-regulating attribute of self-induction.

Perhaps, however, the most valuable instance of turning an electrical enemy into an electrical ally, is the way in which by the proper use, construction, and arrangement of electro-magnets, a plurality of either telephonic, or partially telephonic and partly telegraphic messages, may be transmitted over the same circuit at the same time.

The pioneer in this kind of work was C. F. Varley, who as early as 1870 took out a patent, No. 1,044, in England, for a combined simultaneous ordinary Morse and harmonic Morse transmission over the same wire; in this system the straight Morse was worked through electro-magnets, while the harmonic branches were led off from the main line from points outside of the electro-magnets.

Carrying on this line of invention, Mr. Van Rysselberghe, of Belgium, and Dr. Roseburgh, of Toronto, Canada, have worked out systems whereby telegraphy and speaking telephony can be at the same time operated over the same circuit.

Since, however, there is enough in either system to fill up a paper devoted to them exclusively, and since this paper is already too long, I find it impossible here to describe them in detail, reserving this possibly for some future occasion.

Self-induction has also been caused to aid in eliminating the disturbing results of extraneous induction caused by parallel circuits, as in the United States patent of Mr. Edison, No. 203,019, of April 30th, 1878, where a telephone circuit is freed from external influences by combining it with an induction coil connected with the disturbing circuits in such a manner that the direct disturbances received in virtue of the parallelism of the contiguous circuits is neutralised by an equal and opposite induction received also from them through the induction coil. This, however, is not a practical expedient.

Closely analogous to the self-inductive regulation of which I have been speaking, is that upon which the efficiency of an electro-motor depends. This was first observed by Jacobi,\* who says:—

"Experimenting on the magnetic force of a bar of soft iron, I sometimes found considerable differences for which I could in no way account. I was curious to know if these differences proceeded from the nature of the iron, or from the weakening of the electric current produced by a voltaic pair of half a foot square of surface. For this reason, I placed in the circuit a galvanometer so distant as not to be affected by the direct magnetism of the bar. I was much astonished to see the needle recoil on placing the armature, and advance on removing it, for it was the first time I had known the double quality of the connecting wire, viz., that of constructing the voltaic current, and at the same time representing an ordinary wire subject to the action of a magnet in motion. The spiral producing a magnet by the voltaic current is at the same time a magnetic electrical spiral in which a magnet is placed.

Hence the solution of the uniform velocity of the magnetic machine. For being set in motion by the magnetising power of a voltaic current, it represents simultaneously an apparatus composed of magnets in motion, and capable of producing a magnetic electrical current in a direction opposite to that of the voltaic current."

Jacobi, in a subsequent paper, practically elucidated the principles of the operation of counter E.M.F. in electro-motors, even as now understood, although he possibly did not state them as we now would. But he clearly showed that a motor may be regarded as a dynamo acting to develop an electromotive force, opposite in

direction to that acting upon it, *i. e.* That the resultant force was of course  $E - e$ , and that this, together with the resistance of circuit, determine the strength of the current. That the motor utilises  $c e$  of the electrical power supplied  $c E$ ; and he furthermore showed that the power developed by the motor,  $c e$ , is at its maximum when  $e$  equals one-half  $E$ .

It may be thought by some that, considering the title of the paper, the principal utilisation to which I have referred, viz., the use in regulation of systems of alternating currents operating on-verters should have been discussed. It does not seem to me that it is necessary; this has often been done, and will again often be done by others much more competent than myself to handle the subject. But it does seem right that one should be found to give due credit for those who in the same line of thought are "not lost, but gone before," and I am glad that I am in a position so to do.

There seems little need for me to cite any more instances, showing that, like nearly all new arts, the art of regulation by means of self-induction and of otherwise usefully employing the counter E.M.F. due thereto, is not quite new, and that while we can congratulate ourselves upon the achievements of the present, we should not fail to respect the foundation layers of the past, for, of a truth, there were giants in those days.

## ABSTRACTS

### OF PUBLISHED SPECIFICATIONS, 1889.

6867. "Improvements in holders for incandescent electric lamps." C. RICHARDSON and G. HILL. Dated April 24. 6d. Claim:—In an electric incandescent lamp-holder or other like fitting, the use of a piece of insulating material of the form of a cylinder with two deep flats, one on each side, or further to be described as shaped in the nature of two washers joined together by a stout web, substantially as shown and described.

7774. "Improvements in means for supplying electric current to road vehicles, boats, and the like." R. C. SAYER. Dated May 4. 8d. In the case of tramcars and vehicles on public roadways, or canal or other boats, the electric current to work their motors is conveyed to them by means of similar line conductors explained in patent application No. 3,487, A.D. 1889, but the wheels are to be inverted and the conductors carried above the vehicles or boats, the latter (the conductors) are to be deepened to act as longitudinal continuous girders when desired for long spans, and reduced to compound wires or cables when desired for short spans or to prevent obstruction. 3 claims.

7808. "An electric alarm attachment for pressure, vacuum, speed, and other gauges." A. JULIAN. Dated May 10. 6d. Claim:—An attachment to pressure, vacuum, speed, and other gauges for sounding an alarm by means of electricity.

8453. "Improvements in regulating electric currents." W. M. MORDEY. Dated May 21. 8d. The apparatus consists of three principal parts, the relay, the regulator, and the resistance or other device required to be moved, controlled, or varied. The relay consists of a core and solenoid arrangement preferably comprising two fixed hollow wooden bobbins wound with wire, and placed vertically and parallel, and having a U-shaped core freely suspended and entering the bobbins from below. The core is of laminated iron or iron wire, to increase its sensitiveness by reducing reactions to a minimum, especially when used with alternate currents. This core controls a contact-maker of any suitable form. 3 claims.

8493. "Improvements in automatic cut-outs for electrical circuits." W. J. STARKEY BARBER-STARKEY. Dated May 22. 8d. The inventor includes a small dynamo or magneto-electric motor in a high resistance shunt from the dynamo or mains. By means of stops or other devices he limits the possible angular motion of the armature of this electro-motor so that it may not rotate continuously whilst its circuit is closed. The spindle of the armature is geared or connected with a switch or device, such as a mercury or brush contact, for opening and closing the main circuit. 7 claims.

9096. "Improvements in telephonic switchboards." H. F. JACKSON and D. SINCLAIR. Dated June 1. 8d. In lieu of a switchboard having the portion which carries the line jacks placed in a vertical position over a single switch table carrying the usual indicators, cords, switches, and other accessories used by the operators in calling and making connections between subscribers, the inventors form a duplex switchboard in which the part carrying the line jacks is laid horizontally between switch tables on two opposite sides, and each provided with indicators, cords, and other usual accessories, so that operators placed at both switch tables may use the same board to make connections to all the subscribers from any of the two different sets of subscribers whose calls they attend. 4 claims.

9182. "Improvements in apparatus or devices for switching or diverting electric currents, more especially intended for use with telephonic circuits." A. GRAHAM. Dated June 3. 11d. Has more especially for its object to provide an arrangement of switching board and devices for telephonic circuits, whereby they can be used for switching or diverting the currents, whatever the arrangement of the circuits may be. 5 claims.

\* Sturgeon's Annals of Electricity, 1837, Vol. I., pp. 408-419.

9183. "An improved exciting liquid for electric batteries." Dated June 3. 4d. M. SÜSSMANN. Claims:—1. An exciting liquid for electric batteries, consisting of a solution of ferric chloride to which zinc chloride is added. 2. The addition of the chloride of that metal of which the electrode consists to the solution of the ferric chloride.

9294. "Improvements in and relating to dynamo-electric machines and electric motors." H. H. LAKE. (Communicated from abroad by C. S. Bradley, of America.) Dated June 4. 1s. 1d. Consists in an electric motor or dynamo-electric machine of any class to which the invention is applicable, having its field magnets energised by currents induced in the mass of the magnet itself as distinguished from the magnetism produced in the field magnet by a current or currents circulating in insulated conductors wound upon the magnet. The invention further consists in the construction and arrangement of parts for the above ends, and the combination of devices used in starting and operating the motor. 22 claims.

9713. "Improvements in electric conductors." J. G. LORRAIN, (Communicated from abroad by La Société d'Exploitation des Câbles Electriques, Système Berthoud, Borel, et Compagnie, of Switzerland.) Dated June 12. 6d. The inventor takes a core of any of the usual forms, and upon this he winds in the same direction of progressive revolution two ribbons of paper or the like, one of which ribbons is half a width in advance of the other, so as to effect what is known to engineers as "breaking joint." Over the covering thus formed he winds a second serving consisting as before of two ribbons arranged so as to break joint: but in the case of this serving the direction of winding is the opposite to that of the winding of the first serving. In this manner he proceeds until a sufficient number of servings has been put on to give the desired thickness of dielectric. 3 claims.

9723. "Improvements in grids or containers for the elements or plates of secondary batteries, and moulds to be used in their manufacture." THE ELECTRICAL POWER STORAGE COMPANY and P. J. REA. Dated June 12. 8d. According to this invention a mould or chill is provided for the casting of secondary battery grids or containers for the active material or materials to be rendered active, by means of which the grid is so formed that the material with which the holes therein are to be filled is not liable to split or fall away. 2 claims.

10440. "Improvements in holders for incandescent electric lamps." H. BAYLEY. Dated June 27. 8d. Has for its object simple means for facilitating the attachment and disconnection of the head or cap of a holder for an incandescent electric lamp, and the socket or case thereof for the purpose of wiring the holder. 3 claims.

10556. "An improved manufacture of flexible electric cable." W. E. GRAY. Dated June 29. 6d. The inventor provides a metallic core consisting of a bundle of fine copper wires slightly twisted; this he covers with insulating material, then braids over the insulating material in the usual way. The cable thus far made is enveloped in a flexible metallic sheathing composed of, say, twelve strands of steel or iron wire, each strand being composed of, say, seven wires, No. 20 gauge, specially compounded. This flexible sheathing is covered with a suitable tape, and after coating this with a preservative compound, the cable is completed by braiding upon it a strong covering of hemp or jute. 1 claim.

10699. "Apparatus for automatically regulating the potential in the conductors for two or more sets of electrical lamps." SIEMENS BROTHERS AND COMPANY. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 2. 8d. Relates to means of automatically regulating the potential in the conductors for two or more sets of electrical lamps, when two or more sets of lamps are connected in series, and the conductors are so arranged that all of them, except the two end ones, are common to two sets of lamps. 1 claim.

10933. "Improvements in electro-motors." M. VON DOLIVO-DOBROWOLSKY and the ALLGEMEINE ELECTRICITÄTS-GESELLSCHAFT. Dated July 6. 8d. Claim:—In a secondary electric machine the combination with a magnetic field of an armature composed of an iron body of rotation, bars, strips, or wires of copper arranged transversely to the direction of rotation of the machine, and also transversely to the lines of force of the magnetic field and copper conductors, whereby the said bars, strips, or wires are connected together at both ends, substantially as described.

11049. "Improvements in dynamo-electric machines, in part applicable to electro-motors." J. J. WOOD. Dated July 9. 1s. 1d. Consists, firstly, in an improved method of winding the armature, whereby the short-circuiting of the armature coils within themselves is prevented; and, secondly, in improved means for effecting the automatic regulation of the current generated, in order to maintain it at a uniform volume. 3 claims.

11832. "Improvements in junctions or couplers for electrical conductors." F. R. DOLBY. Dated July 25. 6d. The inventor forms one or more parts or all the parts of the couplers, so that a current of electricity may be passed round them or through them in order to magnetise such part or parts, which will be made of some magnetisable material, the object being to cause the parts of the coupler to be attracted to one another, and so cause a grip, and at the same time by such pressure to make good contact for the passage of the current or currents through the conductors thus joined together. 2 claims.

12773. "Improvements in apparatus used for electric railways." F. WHEELER. (Under International Convention.) Dated January 14. 8d. Consists in constructing a trolley, which, when applied to line conductors suitably supported, cannot, without intention, be removed therefrom. To attain this object the inventor employs in connection with two line conductors or wires, supported at intervals by brackets, the arms of which extend from the centre outward, a trolley, the wheels or rollers of which are supported from the outside of said conductors. 6 claims.

12901. "Improved means for supporting and separating the plates of electric accumulators." R. E. B. CROMPTON. Dated August 15. 6d. The plates in the cell rest on two lines of supports, each line of supports consists of two bars placed at convenient distance apart, and notched on their upper surface to receive the plates in alternate order, so that the whole of the positives rest on one bar, and the negatives on the other bar. When viewed from the side the edges of these bars are cut away between the notches, so that the alternate plates pass over them and clear of any possible contact with them. The connecting pieces which separate the two bars in relation to one another are so arranged that in every case vertical surfaces only, on which no deposit can rest, are interposed between the notches which carry the two sets of plates. 3 claims.

13322. "Improvements in the means or apparatus for transmitting electric signals." E. J. P. MERCADIER. Dated August 23. 8d. Consists of:—1. A vibrating body of suitable form, as, for example, a spring plate or a diapason, the vibrations of which are maintained electrically by the complete or partial automatic interruption of an electric current traversing one or more electro-magnets situated in the vicinity of the vibrating body. 2. One or more coils or bobbins, with soft iron core placed in the magnetic field of the electro-magnets, and connected together in series or for quantity. 3 claims.

17088. "Improvement in means for operating mechanical devices electrically, specially applicable to electric meters, electro-motors, electric lamps, and electric cut-outs." W. E. IRISH. Dated October 29. 1s. 1d. Consists in the utilisation of a rod or strip of metal, composing an integral part of the circuit, and affected to expansion or contraction by the passage of the current to operate devices for switching, regulating, and measuring the electrical current, in connection with suitable connecting mechanism. 29 claims.

20660. "An improved electric signalling apparatus." J. O. WINCKLER. Dated December 23. 6d. The object of this invention is to enable miners during their ascent or descent of the mine to give electric signals to the engineer from the cage or lift, as to whether he is to stop, lower, or wind up, also to indicate to the engineer the speed of travel of the cage by electric bell signals. 1 claim.

## CORRESPONDENCE.

### Prof. Elihu Thomson's Alternator.

This machine possesses some interesting features. But is not the theory, as put forward by the American journals, erroneous? Are there any lines of force moved, except in so far as they are brought into existence and made to vary in intensity? It seems to me that the production of current in this case essentially depends on the inductive effect arising from change or variability of magnetism. The variability—for there is no absolute change of magnetism in any part of this machine—is caused by periodically opening and closing a series of magnetic circuits. If a longitudinal section of one half of the machine be considered, it will be seen that the magnetic circuit so formed is alternately closed and only partially opened by the star-shaped armature, so that the resultant current would be proportional to difference between iron and air as magnetic mediums; the break in the magnetic continuity making the necessary magnetic change; and as this break is only partial, depending on the depth of the cavities between the projections of the star-shaped armature, there is neither cessation or reversal of magnetism. Would it not be more correct to call the machine a mechanical transformer?

E. L. Voice.

August 23rd, 1890.

We notice in your publication of August 15th an account of Prof. Thomson's latest dynamo.

It is apparent from the enclosed description of Pyke and Barnett's machine, of which we hold the patents,

that there is a considerable similarity, although their patents cover far more than Prof. Thomson's in the equalisation of the field magnets. The poles of Prof. Thomson's machine have not so much chance of obtaining saturation as ours, as they are only partially covered for an inappreciable period of time. When the inductors are between cogs, the field is partly varied, but in Pyke and Barnett's patents the field is equally closed, so that there is less strain on the inductors, and less pulsation of the shaft, and no loss due to heating, whereas, in Prof. Thomson's machine, it is apparent that there is considerable loss from heating in the field, more particularly the inner revolving part of the same; but in Pyke and Barnett's there is ample space for ventilation.

Pyke and Harris.

August 26th, 1890.

#### Electric Traction.

We have your issue of August 1st, and note, on page 128, your article about our company, and what our cars are doing at Beverly, Mass. Yes, you are "gravely assured" that every word in the article in the *Boston Post* is as stated; and we further believe the last six lines of your article to be true. We have *proved* every point and stand ready to, and are perfectly sure we can, convince anyone of all these statements. If we have all this it is worth looking into, is it not? We advise you to do so. We hand you herewith cuts of our trucks, cars, power house, &c.

Union Electric Car Co.,

By JOHN H. ALLEY, Vice-President.

Boston, August 11th, 1890.

[We can only insert this letter and advise our readers, especially Messrs. Holroyd Smith, Reckenzaun, Elieson, Lineff, &c., to refer back to our issue of August 1st.—EDS. ELEC. REV.]

#### Electrical Endosmosis or Cataphoric Medication.

I am sure that now a prominent electrician like Mr. Edison has spoken on this subject, it will receive the attention it deserves. But the subject has really been before the medical profession for a considerable time, first, as a well-known physiological experiment, and for twelve months at least as a matter of practical application by myself, and doubtless by others.

I showed cases of rheumatoid arthritis and other diseases, under treatment by this method, at a lecture given to my mixed class of medical men and nurses at the Institute of Medical Electricity on November 5th, 1889; I spoke on the subject at the December meeting of the Brussels medical graduates (1889), and on December 11th of the same year I published a paper in the *Medical Press and Circular*, giving in some detail my plan of using the process.

I hope shortly to publish a *series* of cases treated by cataphoric medication, though I have hitherto refrained from doing so, inasmuch as it is unwise to draw conclusions from a single case of any particular disease, or even from a limited number of such cases. I have preferred to wait until circumstances enabled me to bring forward a sufficient number of results.

Arthur Harries, M.D.

August 25th, 1890.

#### Cable Testing.

Considering my youth, inexperience, and past discourtesy, I ought to be deeply grateful that the editors of so learned and scientific a journal as the *ELECTRICAL REVIEW* should have sacrificed more than two pages of their invaluable space to my mental improvement; but, strange as it may appear, I recognise in this action less

of good nature than of a desire to find material to fill the columns of their paper.

Clever as the editors of the *ELECTRICAL REVIEW* have always shown themselves at forecasting events (notably in the case of the Marchant engine, which was to "revolutionise the electric lighting industry"), their prophecy that I should regret having sent them my communication has, contrary (?) to precedent, not been fulfilled, for I am still so deluded as to think that I have not described a method of testing which is so very commonly known, or so ancient as some people would have me believe.

On first seeing such well-known names as Kempe, Webb and Varley appended to letters stating the absolute antiquity of my method, remembering Virgil's sententious lines,

Sum pietate gravem ac meritis si forte virum quem  
Conspexere, silent arrectisque auribus adstant,

I felt inclined to abstain from further comment; but after carefully perusing their letters, I have come to the conclusion that a different course is open to me.

Mr. Kempe says that the method I have described is old, and so obvious as not to require description in any text-book.

I cannot see that my method is any more obvious than Warren's method, yet the latter, which has the great disadvantage of necessitating the cutting of the outside sheath of the cable a large number of times for each fault localised, and which, consequently, is not so expeditious as my method, is described at considerable length in Mr. Kempe's and other text-books. Moreover, it seems strange that in the columns of "The Philosophical Magazine," so recently as 1879, attention should have been drawn to Warren's method, when, according to Mr. Kempe, a method was then already very generally known, which involved no cutting of the outside sheath of the cable.

I have very little to say to Mr. Varley's letter beyond remarking that he has entirely missed the point at issue. The method which he describes, and which, by the way, he evidently considers reflects considerable credit upon its inventor, despite its being, according to Mr. Kempe, so obvious as to need no description, is of course perfectly applicable to G.P. covered wires. If, however, the leads had been covered with tape or felt, the method which Mr. Varley describes would have been of no use.

Another correspondent, whose name is withheld from publication (a procedure which I imagined was contrary to the rules of the *ELECTRICAL REVIEW*), refers me to Culley for a description of the original method of fault-finding by passing lead through an insulated trough. This gentleman seems to think that my method, and the one described in Culley, are identical. If he will take the trouble to read a little further, he will find that the above is not the case, for Culley, having described the method of testing with a trough, goes on to say: "To find a fault in a very highly insulated sheathing, *covered with a good conductor*, Hooper's material, for instance . . . the tape is carefully removed over a space of 6 inches," &c., describing, in fact, Warren's method, to which reference has already been made. My test is certainly not indicated in Culley, as special mention is there made of a method to be adopted (involving cutting of the outside sheath) where the faulty cable is insulated with sheathing covered with a good conductor.

The copy of Kempe's "Electrical Testing," which is in my possession, contains no account of Mr. Jacob's method; the latter has, however, been described to me, and, so far as my memory serves me, I believe it to differ from my own in several essential points. Should, however, this not be the case, my position will be considerably strengthened, for it appears that Mr. Kempe has thought it worth his while to publish this test in his latest edition of "Electrical Testing," which he surely would not have done had the method been so obvious, so ancient, and a matter of such common knowledge as he, in his letter, states it to be.

H. Cuthbert Hall.

THE TELEGRAPHIC JOURNAL AND  
ELECTRICAL REVIEW

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ELECTRIC LIGHTING AS APPLIED TO  
RAILWAY SERVICE.

To those who have noticed the rapid extension of the electric light in America, and its ready application, amongst other institutions, to railway requirements, the apparent indifference of railway companies in England to its advantages must appear somewhat remarkable. Again and again we are tempted to ask, is it indifference or is there any other reason? We do not think England's railway managers, or those who are more directly responsible for the despatch of business, are indifferent to the requirements of their service. They are men specially selected for the onerous posts which they invariably fill with much credit, for their fitness, their ready business qualifications, and their keen appreciation of the value of time and money. We have seen that the light is employed in the interests of certain companies, so that it is clear its advantages are not kept under a bushel by the electrical departments of the several services. Is it that our large railway corporations are so conservative in principle that they cannot sever their connection with oil and gas? Or is it that the cost, being probably more than that now paid for illuminating a given space, is so much less than that required for the electric light? We are inclined to think this is nearer the point. In many instances we know how apt we are to look at any expenditure which may exceed that which we for the present incur. Railway companies now light a goods shed or a marshalling ground for so much. To establish the electric light will call for a special outlay—perhaps of a sensible sum of money. It will cost in maintenance, possibly, more than is paid for the gas as now used? Where is its advantage?

Those who look at the question in this manner will find in it no advantage; but there is another standpoint from which it may be viewed. We have heard it stated that the cost of a fairly heavy installation for the purpose of aiding the working of an important and

somewhat circumscribed goods yard of a London railway depôt was entirely recouped by the suppression of the amount of losses incurred for goods of which the company was annually robbed. Whether this is so or not, we know it to be a fact that so greatly has, and does, the form of lighting now employed aid the working of the yard, that nothing would induce the officials to part with it; whereas, before the work had to be done with a light which practically rendered the darkness more visible, it is now carried on under a light which at all critical points affords an illumination as nearly equal to daylight as artificial light can approach. Trains arrive. The shunter calls for certain roads. Standing near his train, the light shows him the instant the points are set and the road is made. The signal is given to the driver, and in a moment the vehicles for that road are on their way and another road is being asked for to be used in a similar manner. Thus, in ten minutes or a quarter of an hour, is the marshalling or the distribution of a train dealt with, as against a probable hour under the old method of hand and gas lamps. Nor should the question of safety to those engaged in the work be forgotten. Custom, it is said, brings with it contempt. The man who is careful as a new comer, often becomes indifferent to danger the more experienced he grows. With an imperfect light men must, at the best, be always on the alert. With a light which renders clearly visible the approach of vehicles the mishap of a moment should not occur.

Another case, illustrative of the advantage of a sufficiency of light to enable work to be dealt with expeditiously, comes to our memory. The traffic of a large goods depôt, within a hundred miles of St. Martin's-le-Grand, had so increased, that it was found impossible to deal with it during the night in sufficient time to get the trains out before the morning residential traffic took possession of the line. The goods trains were fairly stopping the passenger traffic, and there was no apparently possible way of meeting the difficulty except by increasing the loading accommoda-

tion of the goods station, so as to admit of more vehicles being loaded at a time. This, at the time, was not possible, for the reason that money could not procure the land; had it, however, been procured this form of redress would have involved a combination of the inconvenience till the additional accommodation had been provided. We believe it was due to the ready resources of the goods manager of the line, to which our remarks refer, that the company was delivered from the dilemma in which it was thus placed. It occurred to him to throw more light into the goods sheds and yards, and this he did with no niggard hand. The loading stages and the shunting grounds were, practically, flooded with light. The men worked with freedom; hand lamps were set on one side. The time occupied in handling them was bestowed upon the actual work of loading and unloading the goods. The desired end was secured. The trains were disposed of to their time, and the traffic restored to its normal regularity.

We give these as points in fact, where most important advantages attended the introduction of the electric light, and where, in one instance, it is probable a large outlay for buildings and land was, at all events postponed, if not absolutely saved. They are facts which are probably as well known to the railway companies as to ourselves; and it cannot be doubted that equal advantage might be secured by its employment elsewhere. That its employment effects a saving in labour—in men's time; that it aids despatch; that it is an efficient factor in the suppression of accidents, we think must be clear to all who care to consider its use in the sense in which we have instanced its utility. That it actually costs more than the existing outlay for a very poor and minor light, does not condemn it as more costly in the end. Take into consideration the issues secured, and we question if the advantage is not so greatly on the side of the electric light as to utterly debar any comparison with other illuminants.

Electricity has been of the greatest service to railways. It is difficult to conceive at this moment how the railway work of the country could be dealt with without it. Certain it is that an enormous outlay must have occurred in duplication of lines had not electricity aided in the regulation of the traffic. And it is equally certain that electricity will year by year, and day by day, prove itself, if well and judiciously handled, of still greater service. So many are its applications, so readily does it adapt itself to every requirement, and so exact is its proportionments when in operation, that it readily presents itself to the service of all who desire to avail themselves of it. In the illumination of railway stations, goods depôts, goods yards; in the marshalling of goods trains and in their distribution; in the lighting of passenger trains; in welding, and, possibly, at no distant date, in the operation of machinery now worked by hydraulic power, we see a field of utility great alike to the community at large as, more immediately, to the railway interests. Shortly we may see a large portion of the City of London illuminated by the electric light. It seems but a few years since our attention was drawn to the subdivision

of the arc, and now that we are arranging for the permanent lighting not only of our metropolis, but of many of our most important towns, we may fittingly consider what has been the progress on railways?

Practically, railways have done very little. Some few of our London stations—Paddington, Cannon Street, the London, Brighton and South Coast at Victoria, the London and South Western at Waterloo and Nine Elms, Cannon Street, Charing Cross, Liverpool Street, and the Midland at St. Pancras—have been, and may, we presume, now be regarded as permanently lighted. But out of London we find little doing. At Glasgow we have the St. Enoch's, Glasgow and South Western Station and Hotel, the Central Station and Hotel, the Grangemouth Docks (both Caledonian), the Waverley Station, Edinburgh, and the Underground Railway, Glasgow (North British), illuminated by the same means.

In the provinces, Bradford stands forth as a brilliant exception. The Midland Company has recently built a very fine and commodious station here, to which there is tacked on a charming hotel, replete with all the advantages and comforts of the present period. The whole of this station, booking offices, waiting rooms, approaches, parcels office, cloak room, and all other offices, refreshment rooms, as well as the hotel, are lighted by electricity throughout. The station, in this respect, stands unique. It is the only station, we believe, extant, which has been so equipped.

We do not know the reasons which have induced the Midland directors to thus again signalise themselves as pioneers in the application of a great and useful branch of science, but we feel that we do not stand alone in our admiration of an intelligent corporate body thus recognising and testing in an efficient and broad manner the worth of that in which they probably see a promising future. We understand that, in laying down the machinery for this installation, provision has also been made for lighting the new goods warehouse which is to be raised on the ground occupied by the old passenger station. In this installation we have hydraulic and electric machinery, with boilers, all within the same building, so that the utmost economy will be obtainable in labour.

Before leaving the subject of lighting, we must not omit to add that the Midland is also laying down, and will shortly have in operation, one of the largest arc light installations extant—viz., 150 arc lights—for the illumination of the St. Pancras goods depôt and the new goods warehouses and yards adjoining the St. Pancras passenger station.

The application of electricity to the lighting of railway trains must necessarily feel its way, but the efforts made by the Midland to solve the question bear with them every prospect of success. For some years the London, Brighton and South Coast Railway has been running trains illuminated by this means, the dynamo being driven from the axle of one of the vehicles, and the lights being sustained by one set of accumulators arranged in the same vehicle. The experiments carried out by the Midland have taken a wider scope, and have had for their object the

determination whether electricity is capable of being applied to all the exigencies of railway traffic. Thus, with respect to main-line trains, and others, which are not always coupled, *i.e.*, trains *en bloc*—each vehicle carries its own lighting power, accumulators capable, when fully charged, of sustaining the whole of the lights of the vehicle for a given period—say, six to eight hours—being provided in each carriage. So far the Midland has now had running for some time daily out of London two trains for Manchester and Liverpool, and two trains for Nottingham, Sheffield, Leeds, and Bradford; and, similarly, two trains daily from each of the places named to London. These trains, together with a local “*bloc*” train running between Manchester and Stockport, have the dynamo driven, like the Brighton Company’s trains, from the wheels of one of the vehicles on the train. We understand, however, that the Midland is now proceeding a step further, and fitting other trains, driving the dynamo direct from a small engine placed upon the locomotive.

So far train lighting by electricity has been confined to the Brighton, South Eastern, Great Northern, and Midland. With the exception of the Midland there has been no attempt to deal with trains broken up on the journey, or for slipping coaches, &c., on the way. At the same time it is worthy of mention that experiments to a small extent, and extending over a very short period, have been made by the Great Eastern and Lancashire and Yorkshire Railway Companies.

We can only hope that the experiments which have been undertaken, with so much success so far, by the Brighton, the Great Northern, and the Midland, will be pursued to that successful end which will establish so useful and so favourite a form of light for the comfort of the travelling public. Difficulties invariably accompany new applications, and in the application of electricity to the purpose in question there are, undoubtedly, many new phases to deal with. Apparently these have been, so far, so well met as to leave little doubt of ultimate and complete success.

### THE HOPKINSON AMENDMENT.

HOWEVER dry the subject matter, the perusal of a pile of statutory declarations furnishes, at times, an interesting and instructive occupation. We have read the Hopkinson Amendment Declarations once more before consigning them to the receptacle reserved for ephemeral literature, and with the evidence before us confess that we can find no fault with the decision of the Comptroller-General. The patent of the Brothers Hopkinson is for “improvements in the construction and application of induction coils,” and the patentees applied for leave to amend the above title by specifically limiting their claims to coils used “for electric distribution,” these last three words being proposed to be added to the title. The claims were proposed to be narrowed down to two, which included secondary generators having an approximately closed magnetic circuit of laminated iron—three claims for methods of regulation having been excised. The specification

appears to have been carelessly drawn up, as it contains several clerical errors, for leave to correct which application was also made. These errors are “contact” for “control,” “neutral” for “mutual,” and “perpendicular” for “parallel.” Many sincere and solemn declarations were obtained by the opposition to show that they were not errors at all but that the words proposed to be used instead of them constituted an afterthought on the part of the applicants. However, the Comptroller-General of Patents has allowed the corrections to be made, the fact that the words in question were verbal errors being perfectly clear from the description and drawings—that is to anyone not an expert witness retained by the opposition. As is well known, the expert witness can display the profoundest idiocy or the sharpest intelligence, as occasion may require. Leave to amend the title has not been granted, nor have the claims been narrowed down. The opposition sincerely and solemnly declares that such amendment would entirely alter the scope and bearing of the patent. Perhaps it would; we are not quite sure, but we don’t think so. However, as there is a doubt on the point, the Comptroller has done right in disallowing the proposed amendment. The patentees say that the application of induction coils to electric distribution is clearly implied in their specification, and that this would be understood by any person conversant with electrical engineering who read that document fairly. We say so too, for the frequently employed term “secondary generator” proves this apparatus to be included under the more comprehensive title of induction coil. But this affords no reason for allowing the amendment, and as the scope of a patent admits of more than one interpretation, if there are doubts, they had best be settled in the Law Courts. People who draw up specifications in loose fashion must be prepared for the pleasant contingency of a decision by Judge and Jury.

Electrical Nomenclature.

UNDER the above heading we notice, in the New York *Electrical Engineer* of August 20th, a letter from Professor J. A. Fleming, having especial reference to the proposed connection of the names of Franklin and Henry with the titles of certain electrical units. However much these names are deserving of being held up to admiration, and of being preserved to memory, we think that the mania for inventing fresh terms has been carried to an extreme. Is it not sufficient that the names of Ampère, Faraday, Joule, Ohm, Volta, Watt &c., have been tortured, twisted, and scattered recklessly hither and thither? Must we further submit to an amplification of the already overstocked vocabulary of electrical terms? A veritable craze seems to have taken possession of the electrical world, but there is, after all, an amusing phase of the disease. The writer of the letter above alluded to, suggests that “the practical unit of self-induction in the system of measurement which employs the ampère, volt, ohm, &c., should be called a *hen*.” Oh, shades of poultry yards! will not every barn-yard rooster arise and crow out his indignation? The following paragraph—“and bestow upon the unit a name which carries no suggestion of dimen-

sions, and which is susceptible of being used in such compounds as *micro-hen* and *milli-hen* convenient for subdivisions of the unit," seems to us a direct insult levelled at Dame Partlet and her callow brood. The professor goes on to say, "There is nothing to prevent any one speaking of *true hens*, *legal hens*, or *British Association hens*, if it is required to be very precise." What delicate definitions! Should suggestions of the nature proposed by Professor Fleming be generally adopted, an unlimited field is presented to the aspiring nomenclaturist; the possible variations being almost endless, limited only by the number of names borne by men more or less famous in electrical science. But, perhaps, we have taken Professor Fleming's suggestion too seriously.

Electric Light at  
Bath.

ACCORDING to accounts which have reached us at various periods the electric lighting at Bath is no unmixed blessing. After the installation had been running a short time many complaints were made of faulty lamps; now matters seem to be a little worse. On Sunday night we are told the donkey engine used in the central station to feed the boilers broke down, and the alternators were shut off putting out the incandescent lamps, which were not restarted that evening. Shortly after the arc machines, with the exception of one, were stopped for about three hours, putting out half the street arc lamps and leaving the works in darkness, the men having to work with candles and oil lamps; later on, we are informed, the whole of the public arc lamps were discontinued for an hour. We are afraid this is calculated to bring some one into discredit, whoever that someone may be.

Kemmler's Execution.

WHENEVER we take up an American paper, which is published beyond the sphere of influence controlled by the alternating current party, we find such remarks as the following by no means uncommon: "But the horrible part of the execution, so many papers say, was the fact that the flesh on the top of the head and at the base of the spine was burned, and that death by electricity is therefore a failure." It is very sad indeed to think that a man like Kemmler, who was devoid of all that pertains to humanity, should be slightly burned. This little preface to his hereafter should be considered simply as a preliminary that he might become to some degree accustomed to his future state, and we believe that a continuance of the law which made death by electricity legal will have a salutary effect upon the criminal class in New York State, and that other States might do worse than adopt it.

Elmore's Copper  
Companies.

THE *Financial News* of September 3rd recalls its words of June 11th, to the following effect:—"Next to the rise and fall of the Paris Syndicate, the most important event which has happened in the copper trade of late years is the discovery of the Elmore copper-depositing process," and adds: "When the Société des Métaux fell to pieces, M. Secrétan was under contract to buy the foreign patents for £700,000. Two official statements have just been published respecting the relative estimated value of the shares in the English and Foreign Elmore's Copper Depositing Companies. It is pointed out with regard to the former that the plant now in process of completion will yield a profit of £174,720 per annum, enabling the company to pay a dividend of 100 per cent. and leaving a surplus of

£34,720. It is deduced from this that the shares which now stand at about £7 should be worth £20 each, and Mr. Elmore says that 'at no very distant period they will stand at £50 each.' The shares in the Foreign Company are estimated on the basis of the sale of four groups of patents now in negotiation, the total anticipated receipts from which amount to £566,500, giving £17 each to the priority shares and more than £34 each to the founders' shares, apart from the value of shares in subsidiary companies." The above predictions are very pretty, and doubtless will send a warm thrill of excitement through the holders of Elmore copper shares, but they must, of course, be taken with a grain of salt. We sincerely hope the forecasts will be verified, and that the example of the Société des Métaux may not be followed, for with success no one will be harmed. We should, however, much like to get at genuine manufacturing results rather than the price rigging through means of vague statements of immense profits.

Bleaching by  
Electricity.

THERE was a paragraph in last week's *Engineering* which a practical bleacher informs us could only be made by an enemy to bleaching by electrolysis or a promoter of the Chemical Union. Our correspondent is ready to prove that such results as those reported would be much dearer than bleaching by chloride of lime, and would condemn the electrolytic system if nothing better were done. He encloses us the following letter from the London Electric Bleaching Company to a Manchester firm, and expresses his readiness to conduct the experiments in the presence not only of paper makers but of the representatives of the electrical press:—

*Bleaching by Electricity.*

Dear Sirs,—Referring to our former correspondence, we intend next month to demonstrate on a commercial scale the superiority of our process for bleaching by electricity over the present method by means of bleaching powder. By our process, each manufacturer can produce the quantity of bleach he requires daily, without any more trouble than in preparing the solution of bleaching powder. The plant and machinery are not expensive; and are easily adapted to the present system. The bleach produced by electricity has the same decolorising properties as chloride of lime, and none of its drawbacks. By our electrical process bleachers will be enabled to produce the equivalent of a ton of bleaching powder, at half the present cost. Our demonstrations (which will last a fortnight) will show, 1st. The transformation of common salt and water into bleaching liquor of the required chlorometric strength for the ensuing operations. 2nd. The bleaching of a few cwts., or say half a ton of paper pulp, or of vegetable fibres, in less time, and at half the cost, as compared with when bleaching powder is used. Kindly let us know if you will favour us with your presence, or with that of your representatives, and as soon as our installations are completed, we shall let you know the date of our experiments; and, if you wish it, we will bleach your own materials.

Electric Lighting in  
Birmingham.

IT is probable that big things may be expected in the way of electric lighting at Birmingham very shortly. Already a good many street mains are laid in the central portion of the town, and the work is being rapidly pushed on. The company responsible for this is the Birmingham Electric Supply Company, which had the provisional order transferred to them by Messrs. Chamberlain and Hookham last year. Their order enables them to supply the electric light to the richest neighbourhood, in which are all the public institutions, theatres, banks and offices. It is expected that a station will be erected capable of supplying 20,000 lights. It is high time that the chief town of the Midlands bestirred itself to acquire a good system of electric lighting; private lighting has been carried on, but only in one or two of the theatres and other buildings. It is, therefore, with satisfaction we hear of the work likely to be accomplished by the local company.

## THE HEDGEHOG TRANSFORMER.

LAST year Mr. Swinburne brought forward the theory that an open iron circuit could be made more efficient than any form of closed iron circuit transformer. The loss in a transformer is made up of loss in copper due to resistance and the loss in iron due to hysteresis. In calculating the efficiencies of transformers, the loss in the iron has generally been left completely out of account, and the loss in copper alone considered. Hence the efficiencies of 97 and 98 per cent. claimed for closed iron circuit forms. If the loss by hysteresis is taken into account, allowing the losses as given by Ewing, the loss in iron in closed circuit transformers, as usually designed is some 10 per cent. of the full load. As the loss in iron goes on all the time a transformer is in circuit, this is very serious. The proportion of actual to possible output of energy per day varies in different districts, but in most stations the average use of lamps is less than two hours a day, including all the lamps installed. The transformer must be large enough to feed all the lamps installed, so it runs, say, an average two hours of full load a day. If there is a loss of 10 per cent. of full load in the iron, this gives an actual efficiency of 45 per cent., even neglecting the loss in copper. In the Hedgehog form the proportion of iron is very much reduced. The cross section of the iron is much less, and the length is about one-third of the closed circuit form, as it has not to surround the wire. The result is that, even in small transformers, the iron loss is under 1 per cent. of the full load. One per cent. of the full load gives 89 per cent. all day, neglecting copper loss, against the 45 per cent. of the closed circuit. This is neglecting copper, however, and the copper loss is greater in the Hedgehog form, so this is an exaggerated comparison. Such a transformer really has an efficiency of about 87 per cent. all day.

The theory of the Hedgehog form is this: If a closed iron circuit is used, the iron circuit must be long, to embrace the copper coils. The only way to shorten it is to make the copper coils smaller. This means using a higher current density which, is wasteful, or fewer turns of copper. Fewer turns of copper demands either

Similarly, in a composite magnetic circuit of iron and air, the magnetic resistance is low if there is never a high magnetic current density or induction in the air, which has high specific magnetic resistance. The magnetising current in a Hedgehog is high; but as it is a quarter of a period behind the primary current in phase, and as the primary wire has to be large enough to carry the primary current, the loss in watts is small. As this loss goes on all day, however, it is by no means unimportant, and has to be included in getting out the efficiencies of these transformers. The construction of these transformers, as carried out by Messrs. Swinburne and Co., of Teddington, is very simple. A gun metal casting of cross shaped section forms the backbone. It is spread out at each end, forming legs at one, and taking the circular terminal board at the other. It also carries insulating flanges which form the ends of the coils. Into the four recesses in the core are put four bundles of soft iron wire. These are taped over, and the secondary is wound on. The secondary is then covered with two layers of ebonite, and the flanges are also faced with the same material. The primary is then wound on in two compartments, separated with ebonite after the manner invented by Gramme, so that both ends come outside, and as far removed from each other as possible. The ends of the core are then spread out, and the transformer tested under 4,000 or 5,000 volts; the insulation in megohms being read by a peculiar instrument which measures the effective resistance under an alternating current. As iron cases cannot be used, as they would be magnetised by the transformer, and as any metal would have Foucault currents generated in it, stoneware jars are used for cases. These have lids bolted down with holes for the leads, as shown.

ELECTRIC LIGHTING MANY TIMES  
SUPERIOR TO GAS.\*

By PAUL HOHO.

At a conference which took place in connection with the last general assembly of the Union of Engineers graduated at the University of Louvain. I had occasion to make a comparison between certain figures relative to the yields of an electric incandescent lamp and a jet of gas. I was greatly surprised at the astonishment which my conclusions evoked, even amongst electricians; and I was induced thereby to repeat my calculations in our society with a view to raising a discussion so as to accentuate the affirmative character of the conclusions which might result. In any case it is well to proclaim aloud and to reiterate figures which ought certainly to find a place on the leading page of every engineer's pocket book. The matter is one of extreme simplicity and, frankly, I ought to apologise to you for introducing one so elementary.

The entire question reduces itself to this: What amount of energy is required by an incandescent lamp on the one hand and a gas jet on the other, in order to produce an equal amount of light, for example, an amount equivalent to 16 candles?

Allow me to make a slight digression for the purpose of assisting somewhat in preparing gas for the sentence which is about to be pronounced upon it by figures which admit of no appeal.

The action of the incandescent lamp is based upon the fact that the energy of the electric current in traversing its filament is transformed by reason of the resistance offered by the latter, into calorific energy, which emanates from the filament in the form of calorific rays. But, as you are aware, a solid body if placed in a certain temperature becomes incandescent, that is, a part of the calorific rays becomes luminous.

\* A paper read before the Société Belge d'Electriciens.



a higher induction in the iron, or a greater cross section, and both of these mean greater loss by hysteresis. If the iron circuit is opened, the sides of the embracing core can be removed, so the loss by hysteresis is divided by three. As there is now plenty of room for copper, the turns and cross section can be increased, and the iron reduced still further. The object of introducing the closed iron circuit was to reduce the magnetic resistance. An open circuit transformer has much higher magnetic resistance. The question of magnetic resistance is not so important as might at first sight appear. Its increase demands more excitation, or more magnetomotive force, and this increases the loss in copper. The best form is thus a compromise. The Hedgehog ends are to reduce the magnetic resistance. In a conductive circuit the resistance is low, if the current density is low in all parts where the specific resistance is high.

For the complete utilisation of this property it would be necessary to attain to such a temperature that the proportion of the luminous rays to the total radiation is the maximum. Unfortunately the physical constitution of the filament, as we actually possess it, does not admit of its being placed above a certain temperature, and we are compelled, therefore, to moderate the action of the electricity in the lamps. The incandescent lamp, as far as it goes, is consequently very far from realising our ideal, and in order to bring about its perfect action upon this principle, electricity is compelled to await the progress of chemistry, which I hope will one day give us a body upon which electricity will be able to exercise its action without restraint. I will not expatiate upon what may be reasonably expected by electricity upon this head, but will base my calculations upon results as they have been actually obtained.

As regards the gas jet, I would first of all remark what a singular idea was that which sought to light up the universe by means of a flame. A flame, as you are aware, is essentially composed of gaseous elements, in which is found a comparatively slender quantity of solid particles. Now, we learn by physical science, that from gas, at whatever temperature it may be carried, emanates very little or no light; all its rays are calorific, and the light which emanates from the flame, is exclusively composed of solid particles, notably carbon.

Is it possible to imagine a more irrational method of lighting? You may attempt to excuse it by saying that it has for a long time been the only one we knew. I admit the excuse, and even that it is a serious one, but you must also confess that it is the only one.

*A priori*, we are in a position to foresee the wretched result to be had from a gas jet; and it only remains to compare the figures.

An incandescent lamp of 16 candle-power consumes at its terminals 2, 2½, 2¾, 3 to 3½ watts per candle, or, 32, 36, 40, 48 to 56 watts for every 16 candles, which amounts to 3·2, 3·6, 4, 4·8, 5·6 kilogrammetres per second for every 16 candles.

On the other hand, a 16 candle-power gas jet consumes 180 litres and more per hour.

Now, a cubic metre of gas, by its combustion, gives out 6,000 calories (according to M. Fresca's calculation); and 180 litres will give out  $6,000 \times \frac{180}{1,000} = 1,080$  calories;  $1,080 \text{ calories} = 1,080 \times 424 = 457,920$  kilogrammetres, which a gas jet consumes per hour, that is  $\frac{457,920}{3,600} = 127\cdot20$  kilogrammetres per second.

It only remains now to compare this consumption of energy with that of an incandescent lamp as set out below.

$$\frac{127\cdot20 \text{ kilogrammetres}}{3\cdot2} = 39\cdot75;$$

$$\frac{127\cdot20 \text{ kilogrammetres}}{3\cdot6} = 35\cdot28;$$

$$\frac{127\cdot20 \text{ kilogrammetres}}{4} = 26\cdot50;$$

$$\frac{127\cdot20 \text{ kilogrammetres}}{5\cdot6} = 22\cdot70;$$

From these I conclude that in order to produce a luminous intensity of 16 candles, a gas jet consumes 22·71 to 39·75 times more energy than an incandescent electric lamp, counting the latter at 2 to 3½ watts per candle, and the consumption of gas at 180 litres per hour. I conclude, further, that the incandescent supplies an illumination absolutely 22 to 40 times that of a gas jet.

That is all I had to prove, and I could content myself with pointing out that in order to destroy these conclusions it will be necessary to invalidate the preceding figures, which is, I repeat, impossible. However, as I foresee myself being answered in the eternal refrain of "theory and practice," I will dwell a little longer upon the matter than it really demands.

In the above conclusion I have specified all that the

figures teach; they tell us nothing more, but, above all, nothing less. We therefore have it that the incandescent lamp constitutes a transformer for the production of luminous energy 22 to 40 times more perfect than the gas jet, comparing the two individually without regard to the production of energy by the one, or of gas by the other. This is the first thing to be established.

Next, as regards the production of electric energy and the production of gas.

Energy is present in nature under various forms; under that of chemical energy in carbon and other bodies—as calorific energy, as the energy of gravitation and of masses in movement, for example, the fall and flow of water.

Gas can only be obtained from coal, and, in certain cases, where it already existant in nature, whilst it cannot be drawn from energy which exists in other forms unless in the most roundabout and impossible way.

Electric energy, on the contrary, may be obtained by the transformation of energy existing in any form, with various results. Thus coal may be transformed into electric energy by a series of transformations yielding a feeble result which is successively diminished by each transformation; the mechanical energy which may be employed upon a shaft moved by a fall of water, may be transformed into electric energy and afford results unknown in any other industry, 85, 90, and even 93 per cent., for instance.

Therefore in comparing electricity with gas, it would be absolutely unreasonable to deal with energy as existing under one form only.

If gas, for the sake of a cause which is otherwise indefensible, demands that the comparison be made from the standpoint of the energy of coal compared with that of gas, electricity will not shrink from the comparison; but should electricity in its turn call for a comparison with other forms of energy, the protests of the advocates of gas would only be equalled by the disastrous results to their client.

However, for the production of light, it suffices on principle to have a suitable transformation of energy, nothing but energy, and this as much as possible free from carbon fumes and from the emanations of carbonic acid and other similar products whose influence is little beneficial. It is true that coal is to be found in large quantity in nature, and that in this country, as a rule, it offers the most economical and convenient form of energy for our needs. But we are not merely arguing the case of Brussels, and without admitting the hypothesis that some day or other we shall have to make use of the Niagara Falls, we have still in this country waterfalls and flows which could be easily utilised, and which have, in fact, been so very frequently.

We by no means decline to institute a comparison with gas on the standpoint of coal or of gas even, but first let us point out the insufficiency and exclusiveness of the comparison.

Thus, 10 kilos. of coal furnish a maximum of 3,000 litres of gas, or a quantity sufficient to feed ten jets of 16 candle-power during one hour and forty minutes. To produce electric energy from coal, we are obliged in the first place to transform, by a series of transformations, the energy of coal into mechanical energy and next into electric energy. With the aid of a good condensing engine, 10 kilos. of coal will furnish 8 horse-power hours upon the shaft, by means of which the dynamo electric machine will furnish 8 H.P.H.  $\times 75 \text{ kg.} \times 9\cdot8 \text{ w.} \times 80 \text{ per cent.} = 4,800 \text{ watt-hours}$ , or the amount of energy necessary for supplying 10 incandescent 16 candle lamps during 8¼ths to 15 hours.

Result in favour of electricity:

$$\frac{8\frac{1}{4} \text{ to } 15}{1\frac{2}{3}} = \frac{5\frac{1}{2} \text{ to } 9}{1}$$

and, moreover, the first transformations of the energy, up to the driving shaft, before electricity had come into play, had only furnished a total rendering of 10 per cent.

In fact, 1 kilo. of coal gives an immediate yield of

5,000 calories = 2,120,000 kilogrammetres, whereas upon the driving shaft we have 0.8 H.P.H.  $\times$  75 kg.  $\times$  3,600 s = 216,000 kilogrammetres, which gives a rendering of  $\frac{216,000}{2,120,000} = 0.10 = 10$  per cent.

Let us now make the comparison on the score of gas, that is, by employing the 3,000 litres of gas produced by 10 kilos of coal on the one hand directly in the gas jets, and on the other for producing, by means of various transformations, electrical energy for the supply of incandescent lamps. The 3,000 litres of gas will supply, it is said, 10 jets of 16 candle-power during one hour and 40 minutes. On the other hand they will supply upon the driving shaft of a gas motor  $\frac{3,000}{700} =$

4.286 horse-power hours, by means of which the dynamo will furnish 4.286 H.P.H.  $\times$  75 kg.  $\times$  9.8 w.  $\times$  80 per cent. = 2,560 watts hours, or the amount of energy required for supplying 10 16-candle incandescent lamps during  $\frac{4}{7}$  to 8 hours.

Result in favour of electricity

$$\frac{4\frac{2}{7} \text{ to } 8}{1\frac{2}{3}} = \frac{2.74 \text{ to } 4.8}{1}$$

And, moreover, the gas motor, which consumes 700 litres of gas per horse-hour only returns 15 per cent. yield. In fact 700 litres of gas give immediately

$\frac{700}{1,000} \times 6,000 = 4,200$  calories =  $4,200 \times 424 = 1,780,800$  kilogrammetres; whilst on the driving shaft they gave 75 kg.  $\times$  3,600 = 270,000 kilogrammetres, or  $\frac{270,000}{1,780,000} = 0.15 = 15$  per cent.

These figures point their own conclusions sufficiently clearly, precisely, explicitly and instructively to be developed by us.

I have only to point out what follows as a consequence:

1. The loss which occurs in obtaining electric lighting by means of coal or gas, is not to be attributed to electricity but to the successive transformations of energy with very slender results, before electric energy is obtained.

2. Directly electricity comes into play, that is when mechanical becomes transformed into electrical energy, the yield is enhanced to 80 per cent. (as mentioned in my calculation), and may in fact reach to 85, 90 and 93 per cent. and more.

3. Therefore in spite of the preliminary very unfavourable transformations electricity, a total result is obtained which is notably superior to gas, as I have shown in the foregoing figures.

These will be found to gain in importance and to accentuate the advantages of electricity if we take into consideration the following three facts:

1. The transformation of energy in general in all these forms makes continuous advances. Whilst these advances constitute an immediate advance for electric lighting, they bring with them no advantage for gas lighting. It is true that gas is in no way prejudiced by the transformations undergone by it before its utilisation, but its failure consists entirely in its employment as a lighting medium.

2. The transformation of electric energy is making rapid progress. The same cannot confidently be said of gas, which after over a hundred years of use, finds itself already outstripped by a luminant which hardly counts an existence of 10 years.

3. Electric energy is peculiarly transportable from long distances, a fact which enables it, and will enable it, to overcome local circumstances disadvantageous to its production, by enabling its production in localities where the conditions are more favourable.

## PROGRESS OF TELEGRAPHY IN AUSTRIA.

[FROM A CORRESPONDENT.]

RECENTLY an improvement in the Morse apparatus has been effected by means of an invention made by Joseph Stulc, of Jägerndorf, the manager of the Moravia-Silesia central line. This invention is not an improvement or a simplification of the Morse apparatus itself, but it promises noteworthy results as regards economy of working material. The idea upon which Stulc has effected his arrangement of stations is founded upon the division of the current and upon its insulation. He has arrived at the important result that local batteries can be definitely dispensed with in telegraph working. This is an important advantage in the large telegraph systems of the Government, and in railway lines with many branches, as it involves a great economy of material, and dispenses with the trouble of filling up the batteries and exchanging those which have become unserviceable.

With this invention, which has been arrived at in a very simple and ingenious manner, involving no extra outlay, there are connected other advantages of much importance, especially on railways which have to maintain separate batteries to work signals (bell signals and distance-signals). Thanks to the idea of Stulc, which has been tested experimentally, an economy in working material of nearly 50 per cent. has been attained with a current which does not exceed the normal strength.

Of not less importance is the advantage of the same idea in subdividing the current, as Stulc has succeeded in working with a different strength of current. It often happens that the line current, from different causes, is weakened to such an extent that the Morse apparatus gives only illegible signs, whether because the two stations corresponding with each other are too far apart or that various intervening stations disconnect their arrangements on the approach of a thunderstorm. Stulc has met this difficulty in a most satisfactory manner.

It must further be noticed that Stulc has devised a certain method of protecting the telegraphic stations from lightning.

Another not less surprising success of the same inventor is that he has rendered it practicable not only for stations of the same portion,  $\alpha$ , of the main line, A, to correspond with the stations of the branch line, B—which is nothing new—but also the stations of the portion,  $\beta$ , of the main line, A, may speak with the same branch line, B, a result which has hitherto been impracticable. This is important, for, in the first place, the communication of messages through intermediate stations is a waste of time; and, in the second, it increases the chances of error. Finally, it must be mentioned that Stulc has encountered a misfortune at the very outset. In his delight at the success he opened heart and mouth to a specialist. The latter, abusing his confidence, applied for patents in Austria and Germany. This affair has occasioned an investigation which may possibly have to be decided by the courts of law. Fortunately the "good friend" has not fully grasped the idea of Stulc, so that there are many important defects in the scheme of the patentee. Herr Stulc has received many offers of financial assistance from patent offices abroad.

## WHAT CONSTITUTES A DANGEROUS ELECTRICAL CURRENT?\*

By NELSON W. PERRY, E.M.

PART II.—CONCLUDED.

THE average normal resistance of an adult body from hand to hand may be accepted as 1,000 ohms. As the highest estimates have usually placed the quantity ne-

**Copper in America.**—A representative of one of the largest copper houses in America says the demand for copper wire is beyond the wildest hopes of the manufacturer.

\* *Western Electrician*.

cessary to kill at not more than one ampère, if passed from hand to hand or head to foot, the electromotive force that must be associated with the same idea will be 1,000 volts, because the pressure is capable of forcing just one ampère of current through a resistance of 1,000 ohms. We must not, however, assume from this that all currents of 1,000 volts that pass thus through the body are necessarily fatal, because currents may exist of vastly greater electromotive force but lacking in quantity—such as, for instance, the spark from a Leyden jar, which may be many thousand volts, and yet be so insignificant in quantity as to permit of its being taken without unpleasant effects. Then, again, if we should assume a case in which, say, a single ampère of current would only be just sufficient to cause death, it is not to be taken for granted that death could not be caused in any way by *less* than one ampère.

Prof. Tait and Balfour Stewart, in their joint work, "The Unseen Universe," call attention to the different effects that may be produced by the same amount of energy when applied in different ways, and cite as an illustration, that a pillow weighing 30 lbs., moving at a rate of 10 feet per second, that is a velocity it would attain if it had fallen a little less than 2 feet, has nearly the same energy as a pellet of No. 1 shot as it leaves the muzzle of a fowling piece. "How different the quality of these equal quantities of energy of the same kind," say they.

Then, again, it is observed that a force suddenly applied will often produce very different results from an equal one that has been gradually applied, and an interrupted or alternating current of electricity is found to produce more violent physiological effects than a continuous or steady current of the same electromotive force.

In the present state of our knowledge, it is not possible to arrive at the increased effect quantitatively, but that there is increased effect is a matter of very common experience. Mr. Edison is quoted as having stated that three volts of the alternating current would be fully equivalent, in physiological effects, to eight volts of the direct current. Mr. Westinghouse would probably not admit that there was anywhere nearly so much difference between the two.

It is desirable that we do not here confuse the effects due to the breaking of a circuit.

Everyone is familiar with the thumping that occurs when the water is suddenly turned off in a long pipe. There is no jar when the water is turned on at the faucet, but if the pipe is very long, and the water is under considerable "head," a sudden turning off of the flow may result in such a thump as to burst a pipe capable of withstanding a very much greater pressure than that due to the head of water. In fact, this extra pressure, due to the sudden stoppage of a flow of water, is utilised in the hydraulic ram to force water higher than its source.

Now, in the flow of electricity, we have an exactly similar phenomenon. While the sudden closing or starting of an electric current will produce momentary physiological or magnetic effects in excess of the same current more gradually applied, its electromotive force is not increased by its sudden starting; but if a circuit be suddenly broken, we have effects exactly analogous to those observed in the case of water in a pipe. If the wire be very long, these increased effects become more apparent, and, if the long wire constituting the circuit is coiled many times around a soft iron core, as in the case of an electro-magnet, the voltage may be enormously increased by the breaking of the circuit. This effect, which is said to be due to momentum in the case of water, is called the "extra current," and is ascribed to "self-induction" in the case of the electric current.

In some cases this extra current may be several times as strong as the normal current, and it thus becomes apparent how an otherwise harmless current may become an agent of death.

For instance, where a man might catch hold of a broken trolley wire carrying a current of 500 volts with safety, if it were merely hanging down and not touch-

ing the ground, he would in all probability be instantly killed if he found such a trolley wire lying on the ground and he should pick it up, because in the first case he would be merely completing the circuit through his body to the ground of a current that is usually considered safe, and in the other, by breaking such a circuit already completed, he would get the benefit of the "extra current" which might be several thousand volts.

It may be laid down as a very safe rule to follow, therefore, to be always suspicious of every wire one meets with in these days, but be especially suspicious of every wire one finds lying on the ground. It is harmless there, but it may be exceedingly dangerous to lift it up. If it is a charged wire, and one can never be sure that it is not, it is sure to be more dangerous to handle than its normal current would imply.

While a dose of electricity not sufficient to kill is exceedingly painful, as the writer and almost every other electrician knows by experience, it is perfectly certain that a sufficient dose is perfectly painless.

Jules Verne, in his story, "A Journey to the Moon," places his heroes in an immense projectile, which is fired at the moon from a cannon of suitable proportions. After the projectile has started on its journey, the hero is at first mystified by the fact that he has heard no report of the explosion. He refers to his figures, and finds that, according to his calculations, the projectile should have an initial velocity greater than that of sound. He concludes, therefore, that he could not have heard the explosion because he has kept ahead of the sound.

A little over a year ago the writer, by invitation, formed one of a select audience of gentlemen before whom Prof. Maybridge showed with the lantern a series of instantaneous photographs. In order to make the intervals between the exposures as well as the times of exposures exceedingly short, the plates had been exposed and stopped by means of an electric current.

One very interesting series of pictures that he showed was intended to illustrate the slowness of the brain in receiving impressions. To illustrate this, he had employed two women—one stood in a bath tub and the other stood upon a chair and poured a bucket of water over the former's head and shoulders. In order to make the shock more intense, Prof. Maybridge had had the bucket filled with icewater, unknown to the victim, who would scarcely have consented to the ducking had she known the temperature of the water. One view represented the water tipped over, and the water falling, but not yet quite touching, the girl's head. The next view showed the water already splashing from her head and shoulders, but although the water had already touched her, and some of it had splashed off from her shoulders, still she had not yet received the sensation.

The third picture showed her just beginning to respond to the shock, and the subsequent ones illustrated the various phases of this response; but what interests us here in this connection is the second view. The electric current had in that case first exposed the plate, and then after a very short interval had shut it off again; that is to say, had acted twice with an interval of time between the two sufficiently long for the sensitive plate to take an impression of the view, and this after the icewater had touched the woman's shoulders, and *before* she was conscious of it.

This is the reason that death by electricity if applied in sufficient doses must be absolutely painless, that with the velocity of light, or at about 186,000 miles per second, the impulse has gone on its way and completed its work. In fact, there are reasons for believing that death by this means is so swift that the dose could be repeated a number of times within the interval that is known to elapse between the receipt of an injury and the cognizance of it by the brain.

In receiving an electric shock it makes a very great difference how we have come in contact with the current, and in accidental cases it is almost impossible to tell just what the conditions were, and consequently how

much current passed through the body. For instance, let us take an ordinary arc light circuit such as are common in all of our cities. Such a circuit carries a current usually of 9.6 amperes at a pressure of 45 volts. I speak of this kind of circuit because in the popular mind it is considered particularly deadly. One may catch hold of the bare conductor with both hands without feeling the slightest shock, because then the body forms what is called a "derived circuit" of high resistance, while the wire between the hands is of very low resistance. The law of flow in such cases is that the current will divide itself among all paths to which it has access in proportion to the conductivity of those paths. In the case just cited the conductivity of the wire between the hands may be 5,000 times as great as that of the body, and in that case 5,000 times as much current would take that path as the other, leaving  $\frac{9.6}{5000}$ ths ampere the quantity that would pass through the body—a quantity so small as not to be perceptible.

If one placed his hands on the wire so that a lamp came in between them, the resistance of the lamp would be added to that of the metallic path, and its conductivity would no longer be 5,000 times as great as that of the body—it would be less, and therefore a greater proportion of the current would pass through the body than in the first case. The greater the number of lamps "short-circuited," as the technical phrase is, the smaller the proportion of the current that will follow the wire, until if so many lamps and other resistances are included between the two hands that the resistance of that part of the current is as great as that of the body, then half the current will pass through the body, and half will follow the wire.

It might be perfectly safe, therefore, to catch hold of both of the wires of the so-called deadly arc light circuit if one were sufficiently far from the dynamo so that there were but two or three lights beyond him, whereas it would be surely fatal to do the same thing near the dynamo, where, by so doing, one would short-circuit many or all of the lamps on the circuit as well as the resistance of the circuit itself.

In practice, however, it is never safe to touch even one of the bare wires of such a circuit unless perfectly insulated from the ground, for the reason that there are liable to be leaks or ground connections somewhere along the line, and by touching one wire, while standing upon the ground, a path would be opened for the current from the point touched through the body and the earth to the leak, thus short-circuiting all of the resistances between the two points.

It is therefore another safe rule to follow—never connect two points of an electric circuit between which there exists a high resistance of any kind, by means of the body, as the high resistance forms an obstacle to the passage of the current through that conductor, and forces it to take any other paths open to it.

In the case of a shock by coming into contact with an arc light wire, while in more or less perfect electrical connection with the earth, it is always due to an earth connection somewhere else on the line. It is not infrequently claimed in such cases that the shock received is due to the full force of the current, which in many arc light circuits runs up to 3,000 volts or over. This, of course, is seldom true. In fact, in such cases it is usually utterly impossible to tell just what current was received; first, because the exact location of the leak or leaks on the line is usually never known at the time of the accident, and therefore it is impossible to tell just how many lamps or other resistances have been short-circuited; and then, in the second place, the normal resistance of the body is usually not the only one concerned in the short-circuit—there is the undetermined resistance of the boots, and also of the ladder, or whatever else one is standing on, and also the resistance due to imperfect contact with the wire as well as that of the leak itself. Since the quantity of current that will pass through the body is dependent upon all of these factors which are usually undeterminate, any statement as to what current a man received under such circumstances is at best the merest guess, and usually the poorest kind of a guess at that. We now

see, however, how one man may be killed and another be only slightly injured from contact with the same circuit.

The case would be somewhat different, however, if, having hold of the conductor with two hands, it should become broken between the points at which it was grasped. The body would then be virtually short-circuiting an infinite resistance, and would receive the full current of the machine up to the capacity of the machine to force it through his resistance. That portion of the circuit nearest the dynamo would be more dangerous to try the experiment on than that portion furthest removed—in fact, there would be no difference where it was tried; it could have but one result in the case of machines of large capacity, viz., death. The various high resistances which different investigators have attributed to the human body, aside from the other modifying causes that I have shown, make it apparent how possible it is, under circumstances otherwise apparently favourable, for a person to receive a very slight shock comparatively from a very strong current.

On the other hand, several electricians have testified that they have taken currents of very high electromotive force—one in particular testifies to having taken 10,000 volts, and the fact that he lived to tell it is evidence enough that it was not fatal. I have no reason whatever to doubt that it was so, and if there were any object in doing it, or rather if there were sufficient object, I would not hesitate to take myself an alternating current of the same or even greater voltage. I should want to take it in my own way, however, and I could do it without fear of fatal effects, whereas I should feel sure of being instantly killed if I took one ampere of current at 1,000 volts from hand to hand, or from head to foot in the most approved way.

Another feature that has undoubtedly been a very potent factor in the discussion of this question of the uncertainty of the physiological results from the electric current should be referred to. In 1888, the State of New York enacted a statute substituting death by electricity for death by hanging. Any change so radical as this would naturally have attracted wide attention and given rise to considerable discussion, and indeed, with the information then at hand as to the behaviour of the human body towards electricity, there seemed ample grounds for a difference of opinion not only as to the advisability of the change, but also as to the practicability and certainty of the new method. Of course, none of the manufacturers was willing to have his machine used for this purpose. The electrical journals of the day teemed with contributed and editorial comments favouring the views of the manufacturers, and the validity of the law authorising the execution of criminals by electricity was severely attacked, and not allowed to rest until affirmed by the highest court. The electrician, through whose instrumentality the machines were procured, and other arrangements for the carrying out of the law were made, was professionally ostracised and branded with most opprobrious epithets, and every endeavour made to manufacture a public opinion against which it would be impossible for such a law to stand.

The company, whose machines were procured, is the one that has been most active in the introduction of what are known as high potential alternating currents. Their business rivals, who confine themselves to the use of the direct current usually at lower potentials, were not slow to take advantage of what appeared to them a business opportunity, and we therefore have seen arrayed against each other the representatives of the two systems—the high potential, and especially the alternating current representatives—trying to defeat the execution of the law, and using every argument that presented itself to prove the extreme variability of the resistance of the human body, and therefore the uncertainty in any given case as to the probable action of a given electromotive force, and the low potential men endeavouring to prove the necessarily dangerous character of all high potential currents in general, and of alternating currents in particular.

Thus we have had the leading representatives of the two systems appearing in print in one of our leading periodicals, each showing the harmlessness of his own system, and the dangers of the other, and each suggesting a series of precautions, which, if observed, would reduce the danger from electrical currents to a minimum, in a way perfectly satisfactory, doubtless, to himself, but not to the other, because in each case the following of the suggestions of each necessarily involved the abandonment of his opponent's system.

Since perhaps the majority of electricians actively engaged in this country are identified with either one or the other of these two great interests, we find them, too, taking sides—usually with the interest with which they are connected. The old saying that “the wish is often father to the thought” is not merely a pleasant jingle of words, but a psychological fact, and we thus have had most sincere arguments on both sides of the question by men who intended to be and were thoroughly honest.

As a person who is identified with neither party, and yet who has business affiliations with both, I have thought that I could discuss the question free from the bias that has naturally existed in many other instances, and my conclusions from the facts and evidence at hand are, that a large majority of those who are free to weigh the evidence dispassionately are in no uncertain mind that a single ampère of current passing through the body from hand to hand or from head to foot is as surely fatal as anything we know.

I also believe with a great many who have given this subject much thought that a very much less quantity than one ampère would be sufficient to insure immediate death. I have little sympathy, however, with the attempt that has been made to distort the facts in the case to the injury of the business of one of our largest electrical interests, or with that other attempt to create a false sentiment against the so-called “debasement of science,” which it is claimed is involved in the substitution of the electric current for the guillotine or the halter.

### COMPARATIVE TESTS OF LEATHER AND CANVAS-RUBBER BELTS.\*

By SAMUEL WEBBER, C.E.

THE question of belting for driving the high speed dynamos in electric light and power stations, is one of considerable importance, and one on which I am often called to express an opinion.

In the first place, let me lay down as a general law, too often neglected, that the value and driving power of a belt depends upon its complete flexibility, and also on its evenness and softness of surface; which two qualities combined, permit perfect contact with, and close adhesion to, the surface of the pulleys. The next point is the weight of the belt itself, which should be as light as possible, consistent with the extreme power to be transmitted by it. This not only saves waste of power in keeping the belt itself in motion, but reduces the centrifugal action that tends to keep the belt from coming in proper contact with a small pulley at high speed. This matter, though important, is often overstated, much of the trouble often noticed being due to the rigidity and inflexibility of the belt, particularly if a double one, rather than to its centrifugal action. If anyone has ever noticed the action of one of the great cotton mill belts, at Lowell or Fall River, running at a speed of a mile a minute, on a pulley 5, 6, or 7 feet in diameter, he will remember that he has never seen much centrifugal action keeping the belt away from the pulley; but if he has seen a double belt, even at 3,000 feet per minute, run on a 12 inch pulley, he will have noticed a perceptible loss of contact.

For these reasons I would always discourage the use of a double belt, when a single one will answer the purpose on any reasonable width of pulley, or, in any

case, when the pulley is less than 12 inches diameter. Belts can be run as fast as 6,000 feet per minute with perfect safety, and if flexible, will cling to the pulley, and lose nothing by centrifugal action. The consideration of weight leads me to disapprove of the so-called “link belts.” Even with the latest, and I believe the best of these belts, the “Acme” belt of the Page Belting Company, of Concord, N.H., the weight of the belt is given me as 4 lbs. 4 ozs. per square foot, of which 3 lbs. 3 ozs. is leather, and 1 lb. 1 oz. iron.

Now, a first-class single leather belt,  $\frac{1}{8}$ th inch thick, weighs just about 1 lb. per square foot, and I believe that an equal weight of leather, in its normal and natural condition, will transmit more power, with less loss, than if chopped up into scraps and bolted together again, in any way whatsoever.

The cost of leather has led to very many experiments to provide an economical substitute, and the first one of these to notice is the “rubber belt,” or, in other words, a belt composed of several folds of canvas, covered and cemented together with a solution of India-rubber. For work in dye-houses and bleacheries this has proved very valuable; but it is soon destroyed by heat and dust, and I am not aware that it has been successfully used as yet for electrical purposes; in fact, with one exception, the cotton-leather belt, of which I shall speak later, I do not yet know of anything to contradict the old saw, “There's nothing like leather.”

I give herewith the results of a series of experiments made by me at the factory of the Underwood Belting Company, Tolland, Conn., to test the comparative driving capacity of various entirely new belts.

The first test I will note was of an entirely new Hoyt belt, one of the best known on the market. This had been in stock some time, but was tested as it was for the sake of information.

This belt was 12 inches wide,  $\frac{1}{4}$ -inch thick, 31 feet long, and weighed  $34\frac{1}{4}$  pounds. With a tension of  $43\frac{1}{2}$  lbs. it drove 7 H.P. (at 754 feet per minute) and then slipped off from stiffness and lack of sufficient tension. The strain was then increased to  $62\frac{1}{2}$  lbs. per foot, and the belt shortened, in doing so,  $4\frac{1}{2}$  inches. It now carried 7.77 H.P. at 697 feet per minute, and with a load of 11.64 H.P. slipped  $10\frac{1}{2}$  per cent., and slipped off when the load was increased.

The strain was then increased to  $83\frac{1}{3}$ rd lbs. per inch, which shortened it  $2\frac{1}{2}$  inches more, and it now carried 8.88 H.P. at 697 feet per minute without slip. As more load was added it began to slip, increasing until with a load of 14.77 H.P. at 660 feet per minute it slipped 13 per cent., and with increased load slipped off. The belt was then reversed, bringing the softer flesh side to the pulley, the hair side having been previously used. It now carried 16.85 H.P. at 662 feet per minute, and then “jumped the pulley” suddenly with increased load, without having shown any perceptible slip previously. This test showed that on the polished iron pulley the soft flesh side held better than the harder grain.

A pair of Dodge's wooden pulleys were now put on, and the belt replaced, with the hair side to the pulley. We now got 15.29 H.P. without slip, at 739 feet per minute, but additional load caused a slip which increased with the load, so that little more power was shown, and the test was stopped at 15.80 H.P. with the belt still on the pulleys, showing a horse-power for each inch of width at 562 feet per minute.

The next test was to cut the belt down to  $8\frac{1}{2}$  inches wide, which gave an apparent strain of 117.6 lbs. per inch, as it was simply relaced in the old holes. This, on the wooden pulleys, gave 10.19 H.P. without slip at 711 feet per minute, and 11.79 H.P. with a slip of 3.77 per cent., at 699 lbs., and then went off with increased load.

A pair of paper pulleys from Westinghouse, Church, Kerr & Co., were then substituted and the belt replaced as in the last trial. It now gave on these pulleys 15.69 H.P. without slip, at 704 feet per minute, or at the rate of 1 H.P. per inch, for 374 feet velocity. This finished the trials of this belt, which came out as good as new, and had not stretched an inch when we got through with it.

\* Electrical World.

We will now compare this with a series of tests of a very soft and flexible belt, known as the "Schultz Rawhide Belt," under the same conditions.

This belt, 31 feet long, 12 inches wide, and  $\frac{3}{16}$ th inch thick, weighed 29 lbs.

It was first tried, as before, with a strain of 43 lbs. per inch on iron pulleys, grain side to the pulley. This likewise proved to be an insufficient strain, and after giving 6 H.P. without slip, and 9.48 H.P. with a slip of 8.43 per cent., at 725 feet per minute, it went off the pulley with increased load. With the increase of strain to 62½ lbs. per inch it gave 11.10 H.P. at 697 feet per minute, and 16.27 H.P. with 5.66 per cent. slip at 675 feet per minute, slipping off with increased load.

With a strain of 83½rd lbs. per inch we got 15.79 without slip at 667 feet per minute, and 19 H.P. with 5.66 per cent. slip at same speed, going off with increased load. This showed 421 feet per minute per horse-power per inch.

We then put on the wooden pulleys, relacing the belt in the old holes, and got 19.80 H.P. without slip at 691 feet per minute, and 26.16 H.P. with a slip of 3 per cent. at 705 feet per minute. With an additional load we got 26.87 at 693 feet per minute with a slip of 4.59 per cent., and with more load "stalled the engine."

This last test showed 309 feet per minute per horse power for each inch of width, and fairly illustrates the difference between a stiff and a flexible belt.

We, however, split this belt down as we had the other one to 8½ inches wide and repeated on the wooden pulleys. Lacing in the old holes, we now got the strain of 117.6 lbs. per inch, which proved too much for the belt, for although we now got 22 H.P., at 691 feet per minute, *without slip*, or at a speed of 261 feet per minute for each inch of width, the belt "jumped the pulleys" with the next increase of load, and when we tried it on the paper pulleys we only got 16.46 H.P. without slip, at 739 feet per minute. The belt slipped off with the next increased load, and on applying the scales we found that the tension had fallen to 77.7 lbs. per inch, and on taking it off we found it permanently stretched 1¼ inches. We were perfectly aware all the time that we were overloading the belt, but our object was to find how much it would stand.

These experiments confirm the already well established fact that a leather belt will safely bear a strain of 350 lbs. per square inch of area, or 87½ lbs. per inch of width for a belt ¼th inch thick, or 66 lbs. for one of  $\frac{1}{16}$ th inch, or an ordinary single belt, and that the latter in good condition, soft and flexible, will easily convey 1 horse-power for each inch of width at 600 feet per minute. They also show very plainly the difference in the hold on the pulley of rigid and flexible belts, and this difference would increase with the velocity on small pulleys, as both the centrifugal force and the entrainment of air would be greater. An ingenious perforated belt for high speed has been introduced lately by Messrs. Chas. A. Schieren & Co., of New York, which I have not seen in operation, but of which the samples impress me favourably. The slight longitudinal perforations are not sufficient to materially weaken the belt, while at the same time they afford an easy passage for entrained air.

I may be thought severe on "link-belts," but my opposition to them is based on sound mechanical principles, for high speed, and if a great power at low speed is required. When shafts and gears are impracticable I should use a metallic link or chain on "sprocket pulleys," rather than trust to friction. With these remarks I will leave the subject of "leather," and turn to my notes on canvas belts of different kinds. The series of experiments to which I have referred shows a test of a simple canvas or duck belt without any preparation. This belt, 31 feet long, 12 inches wide,  $\frac{3}{16}$ th inch thick, weighed 21½ lbs. It stretched 13¼ inches, with a strain of 43½rd lbs. per inch, gave 4.86 H.P. without slip at 754 feet per minute, slipped 3.83 per cent. with 5 H.P., and slipped off with increased load.

When saturated with size, under a strain of 83½rd lbs. per inch, it carried 5.75 H.P. without slip, at 739 feet per minute, then began to slip as the load was increased, until it went off after giving 10.35 H.P. with 9 per cent. slip.

Next came a "Main" or "Gandy belt," 31 feet long, 12 inches wide, and  $\frac{3}{16}$ th inch thick, weighed 41½ lbs. It was composed of heavy cotton cloth, folded and stitched, and saturated with oil and red paint. It stretched 13¼ inches before lacing with the strain of 43½rd lbs. per inch. It carried 7.20 H.P. without slip at 764 feet per minute; with 8.43 H.P. it slipped 8½ per cent., and went off with increased load. With a strain of 62½ lbs. per inch, it stretched 2 inches more, and drove 8.08 H.P., without slip, at 725 feet per minute, slipped 8.70 per cent. with 9.48 H.P., and then slipped off. With 83½rd lbs. per inch, it stretched 3 inches more, and carried 10.48 H.P. without slip at 732 feet per minute. With 14.22 H.P., it slipped 10 per cent., and then went off.

Next comes a four-ply duck belt, weighing just 1 lb. per foot, and saturated with linseed oil and plumbago. This stretched 7¼ inches with 43½rd lbs. per inch, and drove only 2.40 H.P. without slip, it having been dusted with powdered soapstone, to keep it from sticking together in the fold. The soapstone got rid of, and the strain increased to 62½ lbs. per inch, it carried 13.27 H.P. without slip, and went off with an increase of load. At 83½rd lbs. per inch, it carried 16.65 H.P. without slip at 697 feet per minute, but slipped 5.71 per cent. with 17.28 H.P., and then off.

A first-class rubber belt of same dimensions, weighing 37 lbs., showed *no slip* in any test until it finally jumped the pulleys, giving 8.07 H.P. at 725 feet per minute, with 43½rd lbs. strain; 13.68 H.P. at 660 feet per minute, with 62½ lbs. strain, and 18.61 H.P. at 650 feet per minute, with 83½rd lbs. strain, the last test starting the rubber covering. The variations in speed are due to the incapacity of the engine to carry these loads in addition to its regular work.

We now come to the cotton duck leather-lined belt already mentioned. This belt was a four-ply duck, with a soft leather lining cemented on, and weighed 37¼ lbs., of the same size as the others, but was ¼-inch thick, or  $\frac{1}{16}$ th inch duck and  $\frac{1}{16}$ th leather. It stretched 2½ inches with 43½rd lbs., and drove 10.80 H.P. without slip at 754 feet. With 12.4 H.P. it slipped 13 per cent., and then slipped off. With 62½ lbs. per inch strain it carried 11.88 H.P. without slip at 747 feet per minute, stretching 2¼ inches.

It carried 19.40 H.P., with 14.7 per cent. slip at 711 feet, and then slowed down the engine without going off. With the steam increased to 83½rd lbs., it carried 16.98 H.P. without slip at 711 feet per minute, and with 21 H.P. and 9 per cent. slip slowed down the engine to 690 feet, and the test was stopped with the belt still on. All these last tests were on iron pulleys. We now changed to the wooden ones, and got 27.87 H.P. without slip, stopping the engine.

We then split the belt down to 8½ inches, or 117 lbs. per inch, and on the same pulleys got 25½ H.P., with 1 per cent. slip. Changing to paper pulleys, we got 25.30 H.P. *without slip*, but exhausted our power as before, and on applying the scales found the belt to still hold its strain of 1,000 lbs. As will be seen from the above tests, we could not get higher speed with these belts, so we took a five-ply belt of same kind, 5 inches wide,  $\frac{1}{16}$ th inch thick, 31 feet 2 inches long, weighing 19 lbs. This stretched 2¼ inches under a strain of 77 lbs. per inch, and gave 7.20 H.P. on iron pulleys without slip at 754 feet per minute. With 9.80 H.P. it slipped 3½ feet, and with increased load slipped off. On wooden pulleys it drove 10.19 H.P. without slip at 711 feet per minute, or at the rate of 348 feet of belt per minute for a horse-power to each inch. We then put back the iron pulleys and increased the strain to 117 lbs. per inch, and got 10.29 H.P. without slip at 718 feet, and 12.63 H.P. at 698 feet, with 5.65 per cent. slip. We then put on a larger pulley to increase the speed, and under the same strain got 18.62 H.P. without slip at 1,301 feet per minute, and

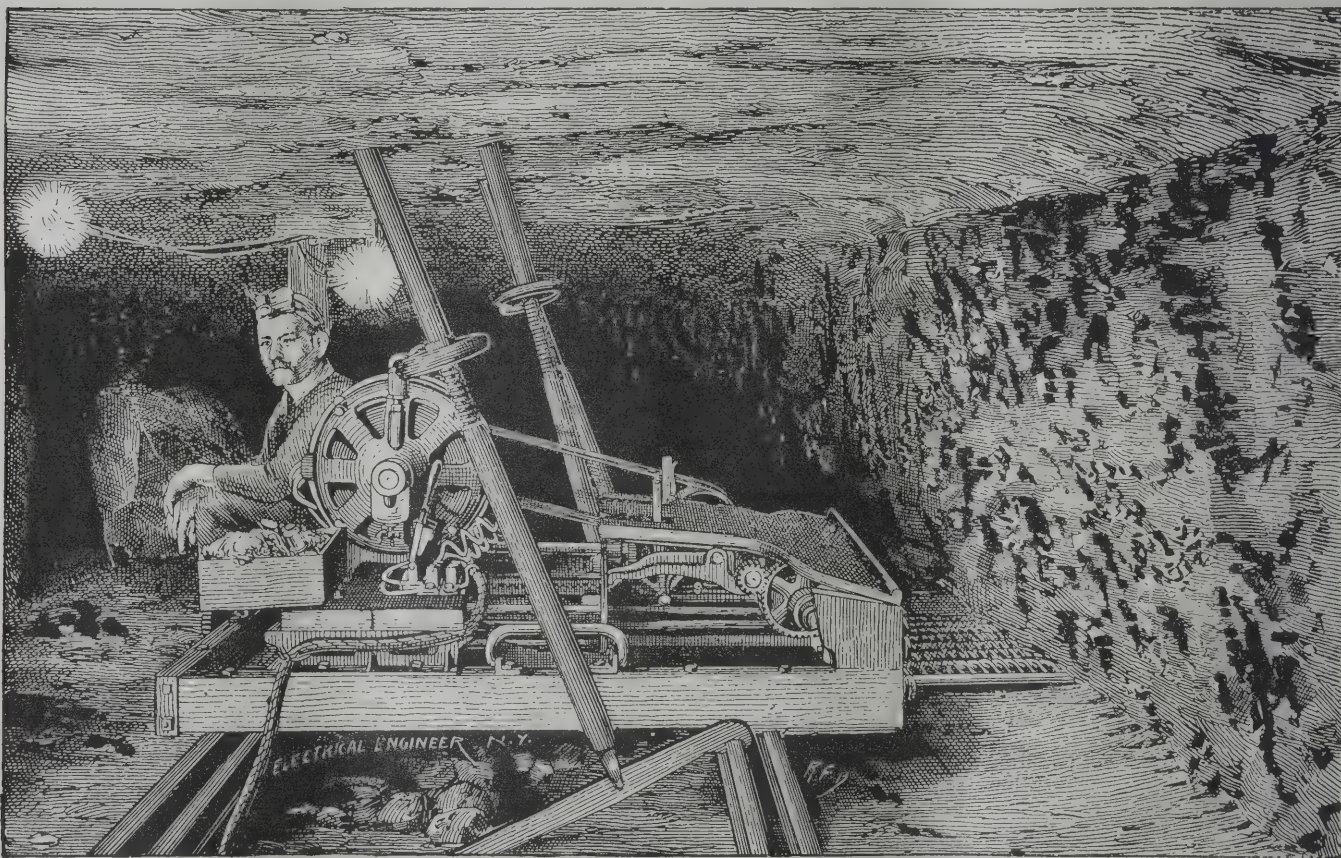
24 H.P. with 1.50 per cent. slip at 1,276 feet, 24.59 H.P. with 3.10 per cent. slip, and 24 H.P. with 5.50 per cent. slip at 1,222 feet per minute, slowing down the engine so that we could not continue the tests. These last two tests, however, go to prove that the slip does not increase with the velocity, and the last three were all stopped in good order, with the belts still on the pulleys. I think they go to prove that a strong light-woven belt, with a leather lining, if the cement is perfect, will be the belt of the future for all magneto-electric machines, as they combine great strength with light weight and great clinging properties.

I do not propose to enter into any discussion which may involve patent rights, but will simply say that while these cotton-leather belts tested were made by the Underwood Manufacturing Company, a very promising belt of the same materials is also made by the Page Belting Company, of Concord, N.H., differing in construction thus: Two canvas belts are used, meeting in the centre, with a single leather lining, which acts as a hinge, and permits the belt to adapt itself closely to a coned pulley.

that no metallic part is exposed. All wood work of the switches is made thoroughly waterproof and the switch handle is detachable and carried by the motor man. This prevents the switch being tampered with by meddlesome persons.

The wire used in these mines is all of the Clark rubber-covered special mine finish type, and all wire connections are made with McIntire connectors. All wood work is made waterproof with P. & B. compound. The coal cutting motors in the rooms are connected to the main line by a specially made insulated flexible cable, which can be coiled on a special reel and taken to another room in a few minutes. This cable when in use is supported by glass hook insulators made for this purpose.

Six "Hercules" coal mining machines, with 3 H.P. Tesla motors mounted thereon, as shown in the engraving, are now in operation in these mines. The machine and motor complete weighs about 1,000 pounds and is easily handled and shifted from room to room by one man. A specially designed truck is used in conveying machine from one room to another.



TESLA MOTOR DRIVING HERCULES COAL MINING MACHINE.

## AN ELECTRIC COAL MINING EQUIPMENT.

A HIGHLY interesting electric plant was recently put in operation in the First Pool Monongahela Gas Coal Co.'s mines at Willock Station, Pa. This electric equipment was designed and installed by the Mill and Mine Electric Equipment Co., of Pittsburgh, Pa., under the supervision of Mr. W. A. Giles, general manager and electrical engineer for the company, who has supplied the following interesting particulars regarding the plant to the *New York Electrical Engineer*.

The power plant consists of two 12 x 20 Carter engines and one 30 H.P. 3-wire, 4-pole Westinghouse self-exciting, alternating generator. All switches, meters, &c., are mounted on a switchboard in a most convenient location to be easily handled. The voltage on the main line is about 300 volts. Inserted in the main line at convenient locations are several specially designed mine switches with safety catch attachments, and all switches used in these mines are so designed

These machines, by means of a set of gang bits or augers, make an undercut 3 inches high, 36 inches wide by 42 inches deep. One man with this machine will average 40 cuts, or about 43 tons of clean cut coal in 10 hours. This is equal to the product of 12 to 14 pick miners.

The ventilating outfit in this mine consists of a 12 feet Pollock fan, with a capacity of 30,000 cubic feet per minute. It is situated at the bottom of a shaft 75 feet deep, and is so arranged that the fan can be changed from an exhaust to a blower in five minutes. This fan is also run with a 3 H.P. Tesla motor.

The pumping outfit consists of a centrifugal pump of a capacity of 90 gallons per minute, mounted on the same truck with 3 H.P. Tesla motor and connected to the same by means of a belt. This pump and motor can be taken to any part of mine and connected to the power line in a few minutes.

These mines have an incandescent electric light plant, consisting of a United States 300 volt, automatic incandescent dynamo, running 150 Sawyer-Man lamps,

mounted in special waterproof mine sockets with rubber insulating joints. These lamps are connected in loops of three in series across the main circuit, and placed along the main entry at a distance of 80 to 90 feet, and three 16-C.P. lamps are placed in each room. This gives perfectly satisfactory illumination and demonstrates the great importance of better light in coal mines.

The following record shows the large amount of work which can be accomplished with but a few machines. Indeed it has been demonstrated that they can work faster than the rooms can be cleaned up of the coal which is brought down. The record, which is taken from the company's books, extends from July 1st to August 8th, and each cut represents about 1<sup>1</sup>/<sub>10</sub> ton of nut coal.

	No. of machines at work.	No. of cuts made.	No. of machine- hours run.
July 1 ... ..	5	113	35 <sup>1</sup> / <sub>2</sub>
" 2 ... ..	4	119	34 <sup>1</sup> / <sub>2</sub>
" 3 ... ..	4	107	29
" 7 ... ..	4	117	32 <sup>1</sup> / <sub>2</sub>
" 8 ... ..	4	109	31
" 9 ... ..	4	140	37
" 10 ... ..	4	127	34 <sup>1</sup> / <sub>2</sub>
" 11 ... ..	4	134	35 <sup>1</sup> / <sub>2</sub>
" 12 ... ..	4	135	35 <sup>1</sup> / <sub>2</sub>
" 14 ... ..	4	130	35
" 15 ... ..	4	134	36 <sup>1</sup> / <sub>2</sub>
" 16 ... ..	4	134	36
" 17 ... ..	4	140	38
" 18 ... ..	3	55	14
" 19 ... ..	3	31	8
" 21 ... ..	3	69	17
" 22 ... ..	4	80	20 <sup>1</sup> / <sub>2</sub>
" 23 ... ..	4	101	29
" 24 ... ..	4	134	36
" 25 ... ..	4	69	19
" 26 ... ..	3	45	12 <sup>1</sup> / <sub>2</sub>
" 28 ... ..	4	124	35 <sup>1</sup> / <sub>2</sub>
" 29 ... ..	4	103	28 <sup>1</sup> / <sub>2</sub>
" 30 ... ..	4	75	21
" 31 ... ..	3	55	16 <sup>1</sup> / <sub>2</sub>
Aug. 1 ... ..	4	118	30 <sup>1</sup> / <sub>2</sub>
" 2 ... ..	4	124	33 <sup>1</sup> / <sub>2</sub>
" 5 ... ..	4	116	35 <sup>1</sup> / <sub>2</sub>
" 6 ... ..	4	127	34
" 7 ... ..	4	141	36
" 8 ... ..	4	130	38

The Mill and Mine Electric Equipment Company is now putting a similar equipment in Mr. Frank Armstrong's Summer Hill Mines at Woodville, Pa.

OUR OCEAN TELEGRAPH MONOPOLIES.

THE *Economist* in its issue of the 23rd ult. has an interesting article, under the above heading, which is as follows :—" We have received a copy of a petition to the Queen on behalf of the British merchants, bankers, shipowners and others carrying on business in Hong-kong, China, and Japan, praying that steps may be taken to set aside a secret convention between the Eastern Extension and Great Northern Telegraph Companies and the Chinese Government, whereby it is understood that a rate of \$2 per word shall continue to be charged, even after the Chinese land lines have effected a junction with the Russian, upon all messages to Europe west of Russia itself. It is argued that thereby a monopoly hurtful to British interests in the East will be maintained, and that Russian merchants will be placed in an exceptional position of favouritism by contrast with the rest of Europe. We are quite aware that the Eastern and Eastern Extension Companies, by agreement with the Great Northern, the Indo-European, and other companies, have taken all precautions available to secure their monopoly and avoid the cutting down of rates. We do not raise an objection to such combination; this is an age of combination. But we must be permitted to welcom-

counter-combinations. The agitation which has ended in an agreement for the reduction of the Australasian cable rates would scarcely have succeeded\* had the Pender companies not desired to take the wind out of the sails of the proposed Pacific cable, which was favoured by Canada, by Queensland, in some degree by New Zealand, and, after a reserved fashion, by the Home Government. When that reduction comes into force, the China and Japan rates will be the highest in the East, and naturally the China merchants feel themselves aggrieved. On the other hand, the cable companies argue that they established the system when the Eastern merchants were only too glad to welcome them on any terms; that they obtained rights which must not be ignored, and that after 20 years the Eastern Company is only paying 6<sup>1</sup>/<sub>2</sub> per cent. upon its ordinary shares, and the Eastern Extension only 7 per cent. Neither the Australasian nor the China merchants, they say, have a right to depreciate their property. Rates, in fact, would remain without alteration indefinitely were it not for agitation backed up by prospects of competition; and the companies, as we have said, strive, by all means in their power, to defer that evil day by repressing competitors whenever they show signs of presenting themselves.

"It is worth while, however, examining into the claims which the various cable companies put forth to an adequate remuneration on their invested capital. Six and a-half and seven per cent., though very fair rates as times go, are nothing extraordinary in themselves upon investments of twenty years' standing. But it must be remembered that these are the rates payable on a watered capital, and that they represent considerably higher returns upon the money actually put into the cables. It is now seventeen or eighteen years since the seven companies connecting this country with the East were amalgamated into two; and those amalgamations were effected in the following manner :—

	Share capital.	Converted per cent.	Capital after conversion.
Anglo-Mediterranean ... ..	£430,000	200	} Eastern Telegraph Co.
Falmouth and Malta... ..	760,000	120	
Marseilles, Algiers, and Malta ... ..	200,000	100	
British Indian ... ..	1,187,500	120	
	£2,577,500		£3,397,000
British Australian ... ..	540,000	110	} Eastern Extension Co.
British Indian Extension... ..	460,000	150	
China Submarine ... ..	525,000	110	
	£1,525,000		£1,997,500

"Thus, the Eastern capital was watered to the amount of £819,500, and the Eastern Extension to the amount of £472,500, and a dividend of 6<sup>1</sup>/<sub>2</sub> per cent. on the Eastern capital should be read as over 8<sup>1</sup>/<sub>2</sub> per cent. on the original capital, while 7 per cent. on the present Extension capital means over 9 per cent. on the capital prior to its being watered. Beyond this, these companies have worked themselves into a very strong position by not dividing to the full extent profits legitimately earned. When the Eastern Company was compounded in 1872 out of the four lines already referred to, their combined reserves only reached £70,000, whereas at the present time the reserve is £600,000, while extensive additions to the system have been effected out of revenue. We do not say that this conservative policy has not been a wise one. Far from it, we consider that the best interests of the proprietors have been consulted. But the dividends paid have been no guide to the profits made, and if requisite, the tariffs could be much reduced without affecting the payments to the shareholders. The Eastern Extension Company have even larger reserves, reaching to as much as £700,000, and this company has likewise made large additions to the cables out of revenue.

"We have, so far, dealt only with the Eastern companies. But it is worthy of remark that the 'stock-watering' in the instances of the Atlantic cable companies was carried to still greater lengths. Not to

\* It will be remembered that the proposed agreement has fallen to the ground.

go back to the original amalgamation of the Anglo-American and Atlantic Telegraph Companies, there was the amalgamation of 1873, when the following additions were made to the capital invested :—

	Original Capital. £		Anglo-American Capital. £
Anglo-American .....	1,675,000	.....	2,548,450
French Atlantic.....	1,650,000	.....	3,451,550
Newfoundland .....	864,520	.....	1,000,000
	4,189,520	.....	7,000,000

"Anglo-American stock now stands at about 50 per cent. discount, but we do not consider this to represent any discount upon the original investment; and we believe that as regards the old Anglo-American capital as it stood prior to 1868, it represents a substantial premium. But without seeking to make too much of those waterings, which occurred sufficiently long ago to have been almost forgotten, it may be pointed out that reductions in tariff are not the loss to the companies that Sir John Pender would argue. In 1868 the Atlantic Company was charging £5 5s. for 20 words, or, say, 5s. 3d. per word on a long message, whereas nowadays 1s. per word brings a far greater revenue. Only, the Anglo-American Company now obtain considerably less than one-half the Atlantic traffic, whereas years ago they had a monopoly such as Sir John Pender rules over now. Fair reductions of tariff are sure in a year or two to bring their own recompense, and if the Eastern Extension and Great Northern Companies seek to disarm opposition and competition, they must be alive to meeting the requirements of modern business."

## REVIEWS.

*Leçons sur L'Electricité professées à l'Institut Electro-Technique Montefiore annexé à l'Université de Liège.* Par ERIC GERARD. Tome II. Canalisation et Distribution de l'énergie électrique; Applications de l'Electricité à la production et à la transmission de la puissance motrice à la Traction, à l'Eclairage et à la Metallurgie. Paris: Gauthier-Villars et Fils, 55, Quai des Grands-Augustins.

We decidedly like this second volume better than the first, as there is more originality in its composition and the information given is very fairly up to date, a point of great importance, seeing the rapid changes which are continually taking place in the science. The author again gives very general information, describing systems employed by various countries, and methods, apparatus, &c., devised by inventors of every nationality. In referring to overhead wires, he gives in full the Board of Trade regulations with regard to the same. Theory is not entered into largely, but when it is considered necessary it is judiciously curtailed. Altogether the writer has done his self-imposed work with great discretion, and has produced a volume which should prove of great use to the pupils of the Institute of which he is director, and to others.

*Illustrated Catalogue and Formulae.* CROMPTON AND COMPANY, LIMITED, Chelmsford and London.

This is an excellent little pocket-book, and although, of course, it is actually issued for advertisement purposes, it is a book which should prove useful to everyone who has anything to do with electric lighting, as it enables estimates, &c., to be drawn up with great facility. It is well worth the one shilling charged for it.

**Thunderstorms to Order.**—A Chicago electrical trading company professes to be able to supply anything in the way of electricity from a push-button to a thunderstorm.

## NOTES.

**Lighting a Flour Mill.**—Messrs. Ernest Scott & Co., electrical engineers, Newcastle-on-Tyne, have obtained the contract for the complete electric light installation for the new flour mill at Dunston, being built by the Co-operative Wholesale Society. This mill when completed will be one of the largest in the kingdom, if not the largest, and the electric light plant which is being put in in duplicate will consist of two 400-light "Tyne" compound-wound dynamos running at 600 revolutions per minute, and 466 16-C.P. incandescent lamps. The arc light installation will consist of one 9-unit "Tyne" compound-wound dynamo and 10 ampère "Tyne" arc lamps in strong water-tight lanterns with reflectors. We hear that Messrs. Ernest Scott & Co. have a considerable quantity of work in hand of all descriptions, including a large contract for the lighting of Messrs. Arthur & Co.'s works in Glasgow, in which two 400-light "Tyne" dynamos will be used. They are also lighting Messrs. John Bright & Bros.' Mills at Rochdale, the new works of the *Bolton Evening News*, and the cold meat rooms of the Northern Counties Ice Company.

**Electric Lighting at Hastings.**—A public meeting for the purpose of considering the electric lighting proposals of the Hastings Town Council was held last week, under the presidency of Mr. H. Chapman. The chairman ridiculed what he described as the electric light "job," and which he feared would be carried into effect unless the ratepayers spoke out. A committee was appointed to request the mayor to call a town's meeting.

**Ship Lighting.**—The contract for lighting four new steamers being built for the Manchester, Sheffield and Lincolnshire Railway Company has been given to Messrs. Paterson and Cooper. Two of these are in hand at Earle's shipyard, Hull, the other two at Swan and Hunter's, Newcastle. Messrs. Paterson have on hand besides the above the ss. *Innamincka*, *Tuskar*, *Arranmore*, *Garnet*, *City of Dundee*, and H.M. training ship *Empress*.

**Lewes Lighting.**—At a recent meeting of the Town Council an estimate for lighting the town electrically was received from the Gülcher (New) Electric Light and Power Company, Limited, based on the following lines. A complete set of plant and apparatus for 240 16-C.P. incandescent lamps will be provided. These lamps may be distributed in any manner desired over 7½ miles of streets. Incandescent lamps of a higher candle-power may be substituted where desired, the total number of lamps being in proportion to the candle-power, i.e., a 32 C.P. incandescent lamp takes the place of 2 16-C.P. lamps, a 48 or 50 C.P. takes the place of 3 and so on. Modifications in the incandescent lamps of this kind will not affect the cost of the installation. Arc lamps of 2,000 C.P. nominal can be supplied to take the place of 12 16-C.P. incandescent lamps, but every such substitution will increase the total cost of the installation by £15. The company undertake to start the running within 16 weeks after date of order. The estimate does not include the supply of lamp-posts as it is presumed the present gas lamp-posts will be utilised for carrying the incandescent lamps. Since a continuous supply of current is not necessary the company feels quite confident that a single set of generating plant is all that is needed to meet the case, but for absolute security recommend the advisability of duplicating the generating plant, this course would entail a further expenditure of £500. The consideration of the matter was adjourned.

**American Theatre Lighting.**—The Duquesne Theatre at Pittsburg, Pa., is to be lighted throughout by electricity with something over 800 lights. Though not as large as some, it is claimed that this will be a model plant.

**Electric Lighting in Germany.**—The municipal councils of German towns would appear to prefer the carrying out of electric lighting schemes rather than place these in the hands of companies. Cassel is to have an installation commencing with 3,000 incandescence lamps; Breslau has voted £50,000 for an illumination to begin with 8,000 lamps, the central station being built to supply 30,000; Cologne has determined on an installation of 12,000 lamps of 16 candles; and at Dusseldorf the corporation has decided on an illumination of 20,000 incandescence lamps at a cost of £100,000.

**Electric Light in Siam.**—Vice-Consul Stringer, of Bangkok, states that last year a Siamese company, called the Siam Electric Light Company, was formed, two of the leading princes being secretary and treasurer respectively. An agreement was entered into between certain Siamese of high rank, of whom the present head of the Treasury is the leading spirit, and the Brush Electric Light Company, by which the latter engaged to supply engineers and material for the establishment of a system of electric lighting in the city within a radius of four miles from the central station in Bangkok. There being no supply of gas, except on the road in front of the Royal Palace, and the thoroughfares being but dimly lighted with oil lamps, the employment of electricity will no doubt place Bangkok in a position superior to that of most Oriental towns. The owners of large rice and saw mills also, many of whom keep their works going day and night, will find the light a great convenience. The shares of the company are now quoted at a premium.

**Electricity for Spectacular Effects.**—A dynamo and a complete electrical plant will be carried by "The Limited Mail" theatrical company, to produce the telegraph and other effects in that play.

**The Electric Light at Godalming.**—This, it will be remembered, was the first town in the United Kingdom to adopt electricity for public lighting. The installation was not a success, and recourse was had again to gas. Now, with a view of giving electric lighting another trial the members of the Town Council are going to visit Bath and inspect the installation there.

**The New York Phonograph Company.**—The various branch phonograph companies of New York have been combined in one corporation, named the New York Phonograph Company, the President of which is J. P. Haines.

**Woodhouse and Rawson United, Limited v. Appleton, Burbey and Williamson.**—A cricket match, between elevens representing the above firms, was played on Saturday last, at Raynes Park, which, after a very exciting game, ended in a victory for the former by one run.

#### Interruptions and Repairs to Submarine Cables and Land Lines:—

Section.	Interrupted.	Repaired.
Cable Hongkong—Foochow ...	21 July, 1890,	26 July, 1890.
" Suakim—Perim ...	9 May	29 "
" Banjoewangie—Roebuck Bay, 11 July	"	2 Aug. "
" Para—Maranham ...	24 "	21 "
Land Line Moulmein—Bangkok	28 "	30 July "
" " Saigon—Bangkok ...	9 Aug.	10 Aug. "
" " " "	13 "	14 "
" " " "	21 "	22 "

**Electrical Nomenclature.**—In a communication which appears in *Industries* of August 29th, Mr. James Swinburne criticises the proposal made by Prof. J. A. Fleming of using the word "hen" (derived from the name of Henry) as the unit of self-induction. The article is but a short one, yet in it there is space to discuss such terms as secohom, parasangs, gilb, gil, lig, dun, nud, scot, frank, cavs, vacs, &c. If this sort of terminology is continued much further, the electrical engineer of say a decade hence will be obliged to carry about with him a technological dictionary.

**Accumulators in Telegraphy.**—Accumulators have been employed to a considerable extent in the central telegraph station at Berlin since the month of October, 1888. The administration set up 25 batteries of Tudor accumulators. The current is distributed in three directions and serves 68 lines, on which 41 Morse and 27 Hughes instruments are worked. The three systems comprise one of 36 wires at 34 volts, another of 12 wires at 40 volts, and the third of six wires at 60 volts, with one wire at 80 volts. The installation has proved so successful that a fourth system is in course of being supplied with current in the same manner. The batteries are capable of working for one month, but are generally recharged every 10 days by means of a Siemens dynamo worked by a gas motor of 8 H.P.

**Telephone Wire.**—It is reported that the French Administration of Posts and Telegraphs has decided to replace the phosphor bronze wires on telephone lines, and the iron wires on telegraph lines, with "Martin" wire, the results of very thorough experiments having conclusively proved the great superiority of the latter. This wire consists of a steel core covered with soft copper.

**The "Peral."**—The following paragraph appears in *Industries* of August 29th:—"The Government will soon publish the official report of the Naval Commissioners appointed to report on the trials of the submarine vessel *Peral*, lately made in Cadiz Bay. It seems that the report, though drawn up in very flattering terms for Lieutenant Peral, nevertheless recommends the Government not to construct any vessel of this class, as the trials have proved that the vessel is unseaworthy, and that it does not offer the conditions required for submarine navigation, even on coasts and in fine weather."

**Cost of Accumulator Traction.**—The Société Française d'Accumulateurs Electriques have issued an estimate as to the cost of accumulator traction on their system. A line equipped with 40 cars would cost £40,000, including the whole of the plant at the generating station, but excluding the cost of the station building. Out of these 40 cars, four would be kept as reserve, and with 36 cars in daily service, they estimate the cost at 28 francs per car kilometre, or 4½d. per car mile. This figure includes the cost of maintaining the rolling stock (including depreciation of batteries) and fixed machinery, and the working expenses at the charging station. Each car would travel 74 miles daily. The actual results, however, on the Barking line, prove that enough has not been allowed for maintenance of batteries.

**Personal.**—We hear that Mr. Arthur C. Cockburn has now ceased to be connected with the Acme Electric Works, his future address being 22, Streatley Road, Brondesbury, N.W., where he will continue to practice as a consulting electrical engineer.

**A Chance for Inventors.**—A New South Wales correspondent to a New York electrical paper complains that there has not yet been introduced a really successful electric sheep-shearing machine. The want of one is badly felt in Australia.

**Electric Traction in Germany.**—The Berlin *Tageblatt* says that the question of electric railways is about to be taken up seriously in Germany.

**Siamese Telegraphs and Telephones.**—The Siamese telegraph service has lately been considerably improved. The department is under the control of a Siamese prince, and most of the *employés* are either German or French. New telegraph stations have been established at Rathburi, Petchaburi, and Bangtaphan. A system of telephones has been laid down in Bangkok, with connections and exchanges on both sides of the river. All the large firms and trading houses, and many private individuals, are subscribers.

**Music by Telephone.**—An experiment made in Berlin, on Tuesday, in transmitting opera music from the Opera House to the Urania Theatre of Science by means of a telephone was a complete success. It is hoped that it will be possible to make an arrangement with the telephone exchanges to furnish other places with music through the telephone.

**Gas by the Pennyworth.**—The Gas and Lighting Committee of the Bolton Corporation have just decided to make an experiment with a new kind of meter, strongly advocated by one or two of the labour representatives for the automatic supply of gas. In some quarters there is a strong aversion to quarterly gas accounts, and the result is that oil is used instead of gas, and to overcome this the Gas Committee have fitted in a few houses a meter which supplies gas on the same principle as the automatic sweetmeat machines—by placing a penny in a slot.

**The Telephone at Sea.**—The telephone has played an important part in the naval manoeuvres of the Swedish fleet. There is a telephonic post on board each vessel, and when lying at anchor they can telephone to one another by means of insulated conductors, which are run down the anchor chains and submerged. In Sweden, trading vessels arriving in dock are quickly connected by telephone to the nearest exchange.

**The Tory Island Cable.**—It has transpired that the opening of the Tory Island cable on Tuesday almost resulted in a fiasco, and the telegram to the Queen was very nearly not being sent at all. Previous to the ceremony, it was found that no communication could be had with the mainland from Tory Island, and on investigation it was discovered that the cable running over the Horehead Bridge was broken. The broken ends of the cable were found lying in the stream, and the connection was established just in time.

**Microphonic Phenomena.**—The series of papers which we have recently published, from the pen of Mr. A. M. Tanner, will, we feel sure, be much appreciated by experimentalists, and his contribution on page 279 will specially appeal to the sympathetic interest of Prof. Hughes. Mr. Tanner has done good service in unearthing the researches of men now forgotten.

**The Annealing of Copper.**—The paper by Mr. Cummins, which we print on another page, demands the attention of all manufacturers of copper.

**Gas versus Electric Light.**—We wonder what complexion the gas journals will put upon the results which M. Paul Hoho describes on page 260? Is it possible that the author may have based his conclusions on false premises; if so, we shall soon see them opposed by our contemporaries.

**Fatal Electrical Accidents.**—New York, August 30th.—A fatal accident, due to electricity, occurred to-day at Wheeling, West Virginia. Two men stepped upon a wire connected with a powerful dynamo, and fell dead. People ran to raise them, and two who were lifting the bodies from off the wire sustained severe electric shocks.

Cincinnati, August 30th.—A fatal electric light accident occurred here to-day. A lineman employed by the electric light company of this city inadvertently grasped a live wire, and was instantly killed. It was found that the unfortunate man's hand had been almost burnt off.

It seems from these telegrams that although electrical execution is said by the opponents of the measure to be quite unreliable, the number of inadvertent fatalities in the States show no signs of diminution.

**Companies Meetings.**—We desire to call attention to the report of the Brush Electrical Engineering Company, Limited. So far as one can judge, the conclusion of the directors seems to be well founded.

**The Telegraphists' Grievance in Dundee.**—Dundee telegraphists have passed resolutions condemning the new order stopping the increase granted to some of the classes until next year, and calling upon those who had participated in the increase to return all the money received.

**Belting.**—To all users of motive power, Mr. Webber's article on belting will be welcome, and perhaps it may be the means of bringing forth the experiences of belt users on this side of the water. Mr. Webber knows of but one exception to the old adage, "There's nothing like leather."

**New Arc Lamps.**—The Sperry Electric Company of Chicago has been granted a patent for an improvement in a single arc lamp, a simple adjustment which at once changes the lamp from an eight to a 16-hour one. The device can be applied to any arc lamp known on the market. This is, we imagine, the outcome of the litigation on double carbon lamps.

**Gas Explosion.**—An explosion of gas occurred on Monday evening last on the premises of Mr. J. W. Tacon, 277, High Holborn. The force of the explosion was of sufficient violence as to partially destroy the shop front, and damage the interior of the establishment, but happily the assistants and others in the place at the time escaped without injury. Mr. Tacon is only removed one door from an electrically lighted shop, having probably the oldest installation of any importance in the metropolis.

**The Late Cable Interruption.**—"The manager of the Telegraph Department informs us that the recent cable interruptions were caused by a very severe earthquake. The duplicate cable, which was repaired yesterday morning, was broken in three places within 65 miles of Banjoewangie. The other two cables are not yet repaired. The following telegram from the general manager of the Eastern Extension Company at Singapore has been received by Mr. W. Warren, the manager of the company in Australasia:—"In restoring duplicate cable Baly Straits ships found for a distance of 30 miles cable much broken and overlaid from effects of disturbances at bottom of ocean. Ship now at work on original Darwin-Java cable." The above extract from the Melbourne *Argus* of July 22nd, 1890, recently to hand, throws a little more light on the simultaneous interruption of the three cables to Australia. From this it appears that the cables were not only ultimately interrupted, but that the first cable repaired was found to be broken in three places; in fact, to quote from the leading article of the same paper on this subject:—"There is now unchallengeable evidence that the company made a serious mistake in running all its cables to Australia from one place, and that the fancied security in which we imagined ourselves to be reposing could only continue so long as an earthquake did not happen near the converging point. We have learned now that it is unwise to put trust in any single means of communication with Europe, and to all intents and purposes the Eastern Company's service is a single service, though the traffic, when all lines are working may be distributed over three routes. The connection at Banjoewangie represents the weakest link and governs the strength of the entire chain. Our interests demand that we must not be deprived of the means of swift correspondence even for a day, and it follows that the service which makes such an interruption possible is ill-suited to our requirements."

**Nalder Brothers and Company.**—The premises in Westminster that have been occupied during the last few years by Messrs. Nalder Bros. & Co. being now found insufficient for their rapidly expanding business, the firm has been obliged to take new works at 16, Red Lion Street, Clerkenwell. These are to be ready by November, and as they will be well equipped with new machinery, improved facilities will be afforded for turning out electrical work of all kinds.

**Contracts by Telephone.**—At the present day the telephone plays an important part in commercial affairs, and most mercantile men find it a great convenience in facilitating and accelerating business. But a recent American lawsuit goes to show that, handy as the telephone may be to business men, the convenience that it affords is not without its drawback. The case to which we—the *Machinery Market*—allude is this:—In an action brought in the United States Courts by the Paddock-Hawley Iron Company against Messrs. Pullis Brothers, it appeared that some iron was ordered by telephone, but that, when the bill was sent in, Messrs. Pullis Brothers demanded a reduction of some 10 per cent., in virtue of an agreement to that effect, which they said had been made by telephone. In reply to this, the plaintiffs asserted that there were only two members of their firm empowered to make such contracts, and that neither of them had heard of this telephonic communication until after this controversy had arisen. The Court held that, while a telephonic contract was as binding as any other, the same rule of evidence applied, and as there was not sufficient evidence to disprove the assertion of the plaintiffs, it was decided that the bill must be paid in full. This appears to be an equitable decision, founded on common sense, and simply serves to point the old moral, that all contracts should be reduced to writing. It is obviously as impossible to bring a telephonic contract into court as any other verbal one.

**Correction.**—In our last issue we referred in our "Official Returns of Electrical Companies" to the business carried on by Messrs. Head, Wrightson and Company, Limited, at South Shields; it should read, "at Stockton-on-Tees."

**Dissolution of Partnership.**—The firm of W. Mackie and Chalmers, electrical engineers, Turk's Head Yard, Turnmill Street, Clerkenwell, has been dissolved by mutual consent, as and from November 30th, 1889. All debts due to and owing by the firm will be received and paid by Matthew William Walbank Mackie.

**Experimental Electric Lights.**—The exhibition of experimental electric lights from points visible in the Needles Channel will be resumed at intervals during the present month.

**Electric Lighting at Portsmouth.**—At Tuesday's meeting of the Portsmouth Town Council, a special committee was appointed to prepare a report as to the best mode of adopting the Electric Lighting Acts. The palatial new Town Hall is already lighted by electricity, and it is known that a strong opinion exists among many of the members of the Corporation that the time has arrived when the municipality should offer to supply the electric light to the inhabitants. On the other hand, considerable opposition is certain to be offered to any such scheme, as the gas interest is somewhat strongly represented in the Portsmouth Town Council.

**University College, Bristol.**—The calendar for the ensuing session, commencing 1st October, is now published. The course of electrical engineering covers three sessions and includes training in electro-technics, mathematics, physics and chemistry, with continuous laboratory work and practice in testing. It is recommended that, inasmuch as an electrical engineer must, in addition to his knowledge of electricity, have a thorough acquaintance with practical engineering, all students who enter for this branch should arrange with some firm either of electrical or of mechanical engineers for a course of training in engineering work. The college authorities have lately arranged for students to spend one or two terms of six months in works during their college career.

**Edinburgh International Exhibition Notes.**—A correspondent sends us the following clippings:—A trip to Slateford in one of the electric launches was then undertaken, and this gave unfeigned pleasure to everybody. For a wonder it wasn't raining, and the atmosphere was clear enough to afford a glimpse of the Forth Bridge in the distance and of the lovely scenery around. The trip out and home occupied exactly 24 minutes. Again, it was feared that Glasgow could derive no benefit from the invention under inspection, for where, except on Finnieston Loch, could electric launches be floated without risk of poisoning the passengers? After dinner the accumulator car used on the Birmingham tramways, and exhibited by the Electric Construction Corporation, was inspected minutely, for here (Bailie Paton declared) was to be found the ultimate solution of the tramway difficulty. The Glasgow gentlemen seated themselves in the car, and listened with evident appreciation to the explanations which Mr. Bennett, standing in the midst, gave. Some of them, and especially Bailie Paton, had evidently studied the subject more than superficially, and from the remarks made it seems clear that electric traction is likely to have a fair field in Glasgow as soon as the Corporation acquire control of the trams. Neither at Glasgow in 1888, nor at Paris last year, was there any example of electric traction, and the authorities of our present exhibition have certainly reason to be proud of the display made. Several of the visitors expressed their astonishment at the extent and scientific character of the exhibition, not unmingled with remorse at having, in some mysterious way, been led to undervalue and depreciate its importance. "Certainly," said one of them, "we had the switchback, but nothing else of importance (?) in the railway line." On account, no doubt, of the existing tramway problem in this city, the attention of the Glasgow magistrates was on Tuesday specially directed to the illustrations of electric traction, in which the exhibition is so rich. No previous exhibition anywhere has boasted more than one example of electric traction; here we have three systems—pick-up current tramway, Telpher, and launch—in actual operation, while a fourth, the accumulator tramway, is shown quiescent in the machinery hall. A successful run was made by the car "Faraday" from the Caledonian end, passing the switchback station without stopping, the whole distance of half a mile being covered in three minutes. At the bandstand end Mr. Bennett explained the system in detail to Bailie Paton and other members of the Tramway Committee. The opinion expressed was that, although good enough for America, the overhead conductor system was not ornamental enough for Glasgow. The next jaunt was on the telpherway, two "specials" being run for their accommodation. On entering the trains there was quite a display of French politeness, each gentleman evidently being afraid of offending his neighbour by taking precedence. However, every one's modesty was at last overcome, and nearly the whole Corporation of Glasgow, Lord Provost, Bailies, and Councillors, were safely suspended on the wire rope with nothing but thin air between them and the daisies. The imagination stands appalled at the consequences of an accident at that moment. St. Mungo would have been like Edinburgh after Flodden, but with ne'er a Provost to comfort her. Happily, the tour was accomplished without a hitch. As the cars swung to and fro when rounding the curves, one could not help thinking that the prayer, "Let Glasgow Flourish," was being answered before one's eyes. It was the general opinion that the Telpher would not do for Glasgow either, except perhaps along the Broomielaw.

**An Electric Insurance Company.**—The Electric Mutual Insurance Company, of Boston, Mass., undertakes the whole risk on stations at fair rates, and return the profits at the expiration of the policy. "It belongs to no boards," it writes. "It makes its own rates. All of its directors are prominent electric light men. It is the electrical industries' own company. It also insures lamps, converters, meters, &c., outside of the station."

**Proposed Lighting of the Manchester Town Hall.**—At the ordinary meeting of the City Council, on Wednesday, Mr. Gunson moved:—"That the Town Hall Committee be instructed to report as to the best means of remedying the present unsatisfactory condition of the ventilating and heating arrangements of the Council Chamber and State rooms, as well as the various committee rooms and offices in the Town Hall; and also as to the advisability of the introduction of an installation for electric lighting." Dr. Simpson seconded the motion, which was accepted by the Mayor on behalf of the Town Hall Committee.

**A Portable Electric Safety Mining Lamp.**—"I have" says M. G. Trouvé, in presenting his memoir to the Académie des Sciences, "to recall to your minds that I have already, in connection with the Saint-Etienne disaster, had the honour to produce before you the first portable electric safety lamp. This lamp is in use in the State powder magazines at Sevrans-Levry and Ripault, as also in the artillery and engineering schools of Versailles, Toul, Verdun, Epinal, Belfort. It is also used by the Parisian Gas Company, and, exclusively of any other, by the Paris fire brigade and the Italian Navy. It furnishes a current of 1.5 ampères and 11.4 volts, *i.e.*, 17.10 watts, lasting three hours, = 51.30 watt-hours. This energy corresponds to an intensity of 4.2 candles for three hours, or of one candle for 11 to 13 hours, an illumination far superior to that of ordinary mining lamps. I am therefore in a position to affirm that this portable electric safety lamp will be found of equal service in mines as it has been to the firemen of Paris, the gas company, &c."

**Copper.**—Under this heading, a financial contemporary speaks at great length on the present condition of the copper industry. The market, now so buoyant, was certainly in a low state during the greater part of 1889, considering that the price of a ton of copper seldom got above the forties. Even when this year opened, the effect of the French Syndicate policy was very apparent, and it was not until there came visible signs of the diminution of the hoarded supplies that the market became firm. Now, however, things are in a very good state, and there is every appearance of a strong market at £60 per ton. Last year there were certainly handsome dividends paid by at least two prominent copper companies, and there is every likelihood that things will be much better this year than last. It is interesting to note the doings of the Copiapo Company. Last year was very nearly its last. There came on the top of the smash of the French Syndicate, a collapse of one of the mine shafts, a misfortune the result of which can scarcely be calculated. In spite of this, however, the shaft was made good, and it actually contrived to pay a respectable dividend of  $6\frac{1}{2}$  per cent., a very creditable wind up for the year 1889.

The *Pall Mall Gazette* says:—"In copper the rise in price which has been going on for some time past is not so much due to speculation as to a legitimate increased consumption with a falling off in the supply. The rise in price, brought about by the manipulation of the market by the French syndicate, so increased the production, and stocks were multiplied at so rapid a rate, that the copper combination found that it had committed itself to a task which it was unable to carry out. Hence the well remembered breakdown of last year. After the collapse the price of copper was, for a time, as low as £35 per ton, and most people thought that it would be years before the large surplus stocks which had accumulated would be disposed of, and the market right itself. But as the rise in price increased production and curtailed consumption, so the heavy fall led to a curtailment of production and increase in the demand, so that there has been a gradual diminution of stocks, until there is now but a small quantity in hand. Here, then, it appears that the recent rise in price is justified, and will be maintained."

**The Telegraph Cable Question.**—The *Daily Chronicle* of September 2nd says, in an evidently inspired "Note":—"The refusal of the Chancellor of the Exchequer to join in the subsidy to the Eastern Extension Telegraph Company, or to share in the guarantee which is necessary to secure the further reduction of the rates, has caused much comment in business circles in Adelaide, and while the parsimony of the Imperial Government is strongly condemned, it is pointed out that the South Australian Government will probably benefit by the refusal, because the Imperial Government must now decline to assist with the subsidy for the proposed Pacific cable, which, if laid, would probably take away a good deal of the telegraph business at present proceeding *via* Port Darwin." As regards the question of the subsidy for the proposed Pacific cable, "the wish was," of course, "father to the thought." There is, however, no doubt whatever that the late interruptions of communications have set people thinking that a Pacific cable is the only way to secure freedom from the disastrous effects of earthquakes in the Java seas.

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#### NEW COMPANIES REGISTERED.

**Sheffield Telephone Exchange and Electric Light Company, Limited.**—Capital £100,000, in £10 shares. Objects: To take over the undertaking of the existing company of the same title, incorporated on the 11th September, 1888. Signatories (with 1 share each): \*J. Tasker, \*G. Senior, \*G. Friklin, C.A., Wm. Johnson (engineer), T. G. Shuttleworth, C.A., R. E. Tasker, \*W. Tasker, all of Sheffield. The signatories denoted by an asterisk and J. Gamble are the first directors. Qualification, 20 shares. Remuneration, £300 per annum, divisible. Registered 28th ult., by J. B. Roberts, 12, Coleman Street, agent for G. J. Simpson, Solicitor, Sheffield.

**Freedman Battery Company, Limited.**—Capital £2,000, in £1 shares. Objects: To acquire the interest of Charles H. Freedman in an invention of which no particulars are given in the registered documents. Signatories (with 1 share each): \*E. F. Wyman, 74, Great Queen Street, Lincoln's Inn; T. F. Baker Evans, Anerley Park; \*C. H. Freedman (electrical engineer), 13, Montague Place, W.C.; T. Douglas Murray, 33, Grosvenor Square; F. Suter (electrical engineer), 6, Ospringe Road; M. Davis, Montreal; H. H. Cooper (electrical engineer), 100, St. Donatt's Road, New Cross. The signatories denoted by an asterisk, and T. F. B. Evans, are the first directors. After 10 per cent. per annum dividend has been declared, the directors may receive such remuneration as may be voted them by the company in general meeting. Registered 1st inst. by Wm. Webb & Co., 6, Essex Street.

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#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**South of England Telephone Company, Limited.**—The annual return of this company, made up to the 1st August, was filed 1st September. The nominal capital is £400,000 divided into 300,000 ordinary shares of £1 each, and 20,000 preference shares of £5 each, the whole of which are taken up, the ordinary shares being considered fully paid. Upon the preference shares £3 10s. per share has been called and paid, the paid-up capital thus being £70,000.

**Telephone Company of Austria, Limited.**—The annual return of this company, made up to the 14th ult., was filed 23rd ult. The nominal capital is £200,000 divided into 20,000 ordinary and 20,000 preference shares of £5 each. The shares taken up are

11,703 ordinary and 6,558 preferred, upon which the full amount has been called. The calls received amount to £33,540, and £57,765 is considered as paid upon 11,553 ordinary shares.

**Sheffield Telephone Exchange and Electric Light Company, Limited.**—At an extraordinary meeting of this company, held at the offices, Commercial Street, Sheffield, on the 14th July, it was resolved to reconstruct, and for such purpose to wind up voluntarily. Mr. Thomas George Shuttleworth, of Sheffield, chartered accountant, and Wm. Johnson, of Sheffield (the secretary), being appointed liquidators.

**Chili Telephone Company, Limited.**—The annual return of this company, made up to the 22nd ult., was filed 29th ult. The nominal capital is £250,000, in £5 shares. 40,000 shares are taken up, upon which the full amount has been called and paid.

**Nonpareil Electric Syndicate Company, Limited.**—The registered office of this company is at 2, Victoria Mansions, Westminster.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Brush Electrical Engineering Company, Limited.

In the first annual report, to be presented to the shareholders at the general meeting of the company to be held at Cannon Street Hotel, London, on the 8th September, 1890, at 12 o'clock noon, the directors submit the balance sheet and profit and loss account, made up to 30th June last.

It is as follows:—

The company was registered on the 10th August, 1889, and the business of the Anglo-American Brush Electric Light Corporation, Limited, was taken over as from the 1st August, 1889, and that of the Falcon Engine and Car Works, Limited, as from the 14th June, 1889, and the accounts made up to the 30th June last are for the periods embraced by these dates. The arrangements for carrying on the business of the Australasian Electric Light and Power Company, Limited, were not completed until much later, and the accompanying accounts do not include any return of business effected by the Australasian branch.

The profit and loss account shows a gross profit of £36,698 16s., and after deducting all standing charges, maintenance of plant and buildings, and interest on debentures, there remains a balance of £14,235 6s. 1d. It is proposed to apply £625 to reduction of preliminary expenses, £500 to reduction of provisional orders account, and £3,000 to reduction of property, patents and goodwill account, to meet depreciation under these heads. The net balance of £10,426 19s. 3d. is available for dividends. An interim dividend, absorbing £3,808 6s. 10d. has already been paid upon the preference shares for the six months from 10th August to 10th February last, and it is proposed to apply £3,505 4s. 6d. to the payment of a further dividend upon these shares, making up the full preferential dividend at the rate of 6 per cent. per annum from the date of registration of company to 30th June, 1890. The directors recommend that the balance of £2,796 14s. 9d. be carried forward to next account.

The temporary interruption to business caused by the amalgamations with other companies and extensions of works has to some extent adversely affected the profit and loss account, and as several months had necessarily to elapse before the new works at Loughborough could be completed, the advantages of the lower cost of production at the country works were not obtained in regard to a large proportion of the orders executed. In view of all these circumstances, the directors consider the result of the year's working as encouraging.

The Falcon works at Loughborough have been considerably enlarged during the year at an expenditure of about £20,000, and the extension of these works enables the company to manufacture at a materially reduced cost engines, boilers, cars, and electrical machinery of practically every description and size. The directors are of opinion that this money has been well spent, and they anticipate good results in the future from the erection of these works.

It affords the directors much satisfaction to state that the Bill confirming the provisional order for lighting the central division of the City of London has been passed by Parliament. The agreement with the Commissioners of Sewers of the City of London provides that the work for the purpose of public lighting shall be commenced within nine months from the 21st May last, and the directors are making the necessary preparations for giving effect to this condition.

The company has also obtained a provisional order for Bournemouth, where a central electric light station has already been erected, which promises to yield very satisfactory returns. The directors have applied to the Board of Trade for provisional orders for several other towns in the United Kingdom where the company has interests to protect.

The Austro-Hungarian businesses have developed in a satisfactory manner, and the Vienna factory shows improving results, both as to volume of trade and as to net profit. The necessity for providing additional factory accommodation in Vienna has now arisen, and the directors are concluding negotiations for the acquisition of some freehold land and buildings adjoining the present works. They have also under consideration proposals for a re-arrangement of the company's interests in the Vienna business.

The directors have, with the assistance of Captain Rowan, the late general manager of the Australasian Company, fully examined into the character of the business acquired from that company, and have made arrangements for the proper development of the company's valuable patents and organisation in the Colonies.

### West Coast of America Telegraph Company.

A MEETING of shareholders was held at Winchester House, on Monday, the 1st inst., at 1 o'clock. The proceedings were strictly of a private nature, and representatives of the press were excluded. We understand that the chairman (Mr. A. Marshall) made a statement as to the position and prospect of the company which was regarded as somewhat reassuring. A short discussion, quiet in character, followed, and the meeting broke up without any resolution being passed.

The following letter appeared on Saturday:—

To the Editor of THE FINANCIAL NEWS.

"Sir,—I beg to enclose a printed notice issued by the directors of this company, whose shares, at the beginning of this year, were quoted at 11½, while they are now scarcely saleable at 3½. This excessive depreciation in value is said to be due to threatened competition; but the eagerness of the shareholders to part with their holdings is, in my opinion, mainly owing to the want of confidence in the management of the company.

"The directors—three in number—take in fees no less a sum than £1,475 per annum. Their business capacity may be judged from the accompanying notice convening a meeting on Monday next, without mentioning the hour at which the shareholders are to attend. From the notice, it would appear as if the shareholders were expected to pass the whole day at 50, Old Broad Street, discussing the company's affairs.

"As the company paid a dividend of 6 per cent. last year, and added £25,000 to the reserve fund, a sum equal to 8 per cent. on the capital, I thought that the shares were worth a small premium, and unfortunately became a purchaser at 10½. I ought, before buying, to have inquired into the administrative ability of the directors, who have succeeded in bringing down the price of the shares some 70 per cent. The published traffics of the company show little or no decrease over the earnings of last year.

"Living in Devonshire, I cannot attend the meeting on Monday next, but I hope that the London shareholders will assemble in force and insist on some reform of the present board of directors.

"I am, sir, yours, &c.,

"A COUNTRY SHAREHOLDER."

**Hartlepool Gas and Water Company.**—At the annual general meeting of the company held recently at Hartlepool, Mr. W. H. Fisher, the chairman, after congratulating the shareholders on a prosperous year, and prognosticating the sustained activity of trade in the district for another year, observed as to the future, that the cost of production of gas would be increased by fully £3,000 in coal, and the necessity of raising the price by 2d. per 1,000 feet had been seriously discussed, but abandoned for the present, in the hope that the increased cost would be partially met by increased consumption—otherwise, the question must be shortly reconsidered.

**The Bankers and Merchants' Telegraph Company.**—The property and franchises of the company have been sold at auction under foreclosure. Colonel Robert G. Ingersoll bid it in for \$390,000.

**The Brush Electrical Engineering Company, Limited.**—The transfer books will be closed to the 9th inst., inclusive.

## TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of August were £2,900, as compared with £2,815 in the corresponding month of last year. The receipts for the month of May, estimated at £3,400, realised £3,409.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of August were £2,073, against £1,624 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of August, 1890, amounted to £46,526, as against £39,489 in the corresponding period, an increase of £7,037.

The Eastern Telegraph Company, Limited. The receipts for the month of August were £32,606, as against £32,012 for the same period of 1889, or an increase of £594.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 31st August are £2,420 as against £2,161, an increase of £259 as compared with the corresponding period.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 29th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,772.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of August, 1890, were £4,960.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (August 28).	Closing Quotation. (September 4.)	Business done during week ending September 4, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	97 — 100		
1,549,160	Anglo-American Telegraph, Limited	Stock	50½ — 51½	51 — 52	51	50
2,725,420	Do. do. 6 p. c. Preferred	Stock	87½ — 88½	87½ — 88½	88½	87½
2,725,420	Do. do. Deferred	Stock	15½ — 15½	15½ — 15½	15	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12½	11½ — 12½	12	
99,000	Do. do. 5 p. c. Bonds	100	100 — 102	100 — 102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 2	1½ — 2		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2		
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	103 — 105	103½	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	5½ — 5½	5½ — 5½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	12½ — 13	12½ — 13		
16,900	Cuba Telegraph, Limited	10	16½ — 17½	16½ — 17½	17½	16½
6,000	Do. do. 10 p. c. Preference	10	3½ — 4	3½ — 4½		
12,931	Direct Spanish Telegraph, Limited	5	9 — 10	9 — 10		
6,090	Do. do. 10 p. c. Preference	5	10½ — 10½	10½ — 10½	10½	10½
60,710	Direct United States Cable, Limited, 1877	20	13½ — 14½	13½ — 14½	14½	13½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	15 — 15½	15 — 15½	15½	15
70,000	Do. 6 p. c. Preference	100	106 — 109	106 — 109	109	108
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	Stock	106 — 109	105 — 108	105	
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	10	14 — 14½	14 — 14½	14½	14
250,000	Eastern Extension, Australasia and China Telegraph, Limited	100	100 — 102	100 — 102		
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	103 — 106	103 — 106		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106	103 — 106		
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	100 — 103	100 — 103		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	10	7½ — 8½	8 — 8½		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	5	4½ — 5½	4½ — 5½		
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	2	6½ — 7½	7½ — 8½	8½	7
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	5	2 — 2½	2 — 2½		
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	10	8½ — 9½	8½ — 9½	9½	8½
180,227	Globe Telegraph and Trust, Limited	10	14½ — 15½	14½ — 15	15	14½
180,042	Do. do. 6 p. c. Preference	10	15½ — 16	15½ — 16½	16½	16½
150,000	Great Northern Tel. Company of Copenhagen	100	100 — 103	100 — 103		
40,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	106 — 109	104 — 107 xd		
250,000	Do. do. (issue of 1883)	10	12 — 13	12 — 13		
9,384	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	18½ — 19½	17½ — 18½	18½	18½
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	100	102 — 104	102 — 104		
200,000	Do. do. 4½ p. c. Deb., 1896	25	37 — 39	37 — 39		
17,000	Indo-European Telegraph, Limited	10	6 — 7	6½ — 7½		
38,348	London Platino-Brazilian Telegraph, Limited	100	107 — 110	105 — 108 xd		
100,000	Do. do. 6 p. c. Debentures	10	4 — 4½	4 — 4½	4½	
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	5	4½ — 5	4½ — 4½	4½	4½
436,700	National Telephone, Limited, Nos. 1 to 436,700	10	12 — 12½	12 — 12½		
15,000	Do. 6 p. c. Cum. 1st Preference	10	10 — 10½	10 — 10½		
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	1	7½ — 8½	7½ — 8½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	8	1 — 1	1 — 1		
9,000	Reuter's, Limited	1	1 — 1	1 — 1		
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	2½ — 3	2½ — 3		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	113 — 117	113 — 117	116	115
3,381	Submarine Cables Trust	5	5 — 5½	5 — 5½	5½	5½
78,949	Swan United Electric Light, Limited (£3½ only paid)	12	42 — 44	42 — 44	43½	42½
37,350	Telegraph Construction and Maintenance, Limited	100	100 — 102	100 — 102		
150,000	Do. do. 5 p. c. Bonds, red. 1894	5	3½ — 4½	3½ — 4		
55,000	United River Plate Telephone, Limited	Stock	90 — 94	90 — 94		
146,000	Do. do. 5 p. c. Debenture Stock	100	9 — 10	9 — 10		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	100 — 103	99 — 102 xd	100½	
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	3 — 4	4 — 5	4	3½
300,000	Do. do. 5 p. c. Debentures	100	103 — 108	101 — 106	104½	103½
30,000	West Coast of America Telegraph, Limited	15	11½ — 11½	11 — 11½	11½	11½
150,000	Do. do. 5 p. c. Cum. Preferred	7½	6½ — 7½	6½ — 7	6½	
64,572	Do. do. 5 p. c. Deferred	7½	4½ — 5½	4½ — 5	4½	4½
26,986	Do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106		
26,986	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 — 104	101 — 104		
200,000	West India and Panama Telegraph, Limited	10	2½ — 3	2½ — 3½	3½	2½
88,321	Do. do. 6 p. c. 1st Preference	10	11½ — 11½	11½ — 12	11½	11½
34,563	Do. do. 6 p. c. 2nd Preference	10	13 — 14	13 — 14		
4,669	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
1,336,000	Do. do. 6 p. c. Sterling Bonds	100	99 — 101	97 — 99 xd		
1179,300	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 1½	1½ — 1½		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7 — 7½.—Elmore Wire, ½ dis—par.—House-to-House Company (£5 paid), 5 — 5½.—International Okonite, Ordinary of £10 (£7 paid), 6½—7½—London Electric Supply Corporation, Ordinary (£5 paid), 1½—2½.—Manchester Edison and Swan Company, £9 (£1 paid), 11/- — 13/-.

## THE ANNEALING OF COPPER.\*

By G. WYCKOFF CUMMINS, New York.

COPPER is at present almost universally annealed in muffles, in which it is raised to the desired temperature and subsequently allowed to cool either in the air or in water. It may be stated, for the benefit of those not versed in the practical work of annealing, that a muffle is nothing more nor less than a reverberatory furnace. It is necessary to watch the copper carefully, so that when it has reached the right temperature it may be drawn from the muffle and allowed to cool. This is extremely important, for it is found that if the copper is heated to too high a temperature, or is left in the muffle at the ordinary temperature of annealing for too long a time, it is "burnt," as the workmen say. Copper that has been "burnt" is yellow, coarsely granular, and exceedingly brittle—so much so that in some samples in my possession it cannot be bent once at a right angle without breaking. It is even more brittle at a red heat than when cold.

In the case of coarse wire it is found that only the surface is "burnt," while the interior is damaged to a far less extent. This causes the exterior to split loose from the interior when bent or when rolled, thus giving the appearance of a brittle copper tube with a copper wire snugly fitted into it. Cracks a half-inch in depth have been observed on the surface of an ingot on its first pass through the rolls, all due to this exterior "burning." It is quite apparent that copper that has been thus overheated in the muffle is entirely unfit for rolling, either for rods or sheet copper or for wire drawing. It is found that the purer forms of copper are far less liable to be harmed by overheating than samples containing even a small amount of impurities. Even the ordinary heating in a muffle will often suffice to "burn" in this manner the surface of some specimens of copper, and thus render them entirely unfit for further working. The explanation of this will be made later. Copper that has been thus ruined is of use only to be refined again.

As may be inferred from the above, only the highest grades of refined copper are at present used for drawing or for rolling. This is not because the lower grades, when refined, cannot stand sufficiently high tests, but because the present methods of working are not adequate to prevent these grades of copper from experiencing the deterioration due to overheating. This is unfortunate for the manufacturer since, I understand, he has to pay cash in advance for the highest grades of refined copper.

In order better to appreciate the explanation of the various phenomena of copper annealing, let us see what refined copper is. The process of refining copper consists in an oxidising action followed by a reducing action which, since it is performed by the aid of gases generated by stirring the melted copper with a pole, is called poling. The object of the oxidation is to oxidise and either volatilise or turn to slag all the impurities contained in the copper. This procedure is materially aided by the fact that the suboxide of copper is freely soluble in metallic copper, and thus penetrates to all parts of the copper, and, parting with its oxygen, oxidises the impurities. The object of the reducing part of the refining process is to change the excess of the suboxide of copper to metallic copper. Copper containing even less than 1 per cent. of the suboxide of copper shows decreased malleability and ductility, and is both cold short and red short. If the copper to be refined contains any impurities, such as arsenic or antimony, it is well not to remove too much of the oxygen in the refining process. If this is done, "overpoled" copper is produced. In this condition it is brittle, granular, of a shiny yellow colour, and more red short than cold short. When the refining has been properly done, and neither too much nor too little oxygen is present, the copper is in the condition of "tough pitch," and is in a fit state to be worked.

"Copper is said to be tough pitch when it requires

frequent bendings to break it, and when, after it is broken, the colour is pale red, the fracture has a silky luster, and is fibrous, like a tuft of silk." On hammering a piece to a thin plate it should show no cracks at the edge. At tough pitch copper offers the highest degree of malleability and ductility of which a given specimen is capable. This is the condition in which refined copper occurs in the market, and if it could be worked without changing this tough pitch any specimen of copper that could be brought to this condition would be suitable for rolling or drawing. We have seen that tough pitch is changed if we either add oxygen to or take oxygen from refined copper.

By far the more important of these is the removal of oxygen, especially from those specimens that contain more than a mere trace of impurities. This is shown by the absolutely worthless condition of overpoled copper. The addition of carbon also plays a very important part in the production of overpoled copper.

That the addition of oxygen to refined copper is not so damaging is shown by the fact that at present nearly all the copper that is worked is considerably oxidised at some stage of the process, and not especially to its detriment.

Let us see how the above facts are related to the process of annealing copper. I have already referred to what is known as "burnt copper." This you may already have recognised as nothing more nor less than copper in the overpoled condition. This is brought about by the action of reducing gases in the muffle. By this means the small amount of oxygen necessary to give the copper its tough pitch is removed. You must remember that this oxygen is combined with impurities in the copper, and thus renders them inert. For example, as explained by Dr. Peters, the oxide of arsenic or antimony is incapable of combining more than mechanically with the copper, but when its oxygen is removed, the arsenic or antimony is left free to combine with the copper. This forms a very brittle alloy, and one that corresponds almost exactly in its properties to overpoled copper. To be sure, overpoled copper is supposed to contain carbon, but that this is not the essential ruining principle in case of annealing is shown by the fact that pure copper does not undergo this change under conditions that ruin impure copper, and also by the fact that the same state may be produced by annealing in pure hydrogen, and thus removing the oxygen that renders the arsenic or antimony inert. No attempt is made to deny the well known fact that carbon does combine with copper to the extent of 0.2 per cent., and cause it to become exceedingly brittle. It is simply claimed that this is probably not what occurs in the production of so-called burnt copper during annealing. The amount of impurities capable of rendering copper easily "burnt" is exceedingly small. This may be better appreciated when it is considered that from 0.01 to 0.2 per cent. expresses the amount of oxygen necessary to render the impurities inert. The removal of this very small amount of oxygen, which is often so small as to be almost within the limits of the errors of analysis, will suffice to render copper overpoled, and ruin it for any use.

Perhaps the most interesting part of this article, to practical men at least, will be the description of a method of avoiding the numerous accidents that may occur in the annealing of copper, due to a change of pitch. As already pointed out, the quality of refined copper is lowered if oxygen be either added to or taken from it. It is quite apparent, therefore, that a really good method of annealing copper will prevent any change in the state of oxidation. To accomplish this it is necessary to prevent access to the heated copper both of atmospheric air, which would oxidise it, and of the reducing gases used in heating the muffle, which would take oxygen away from it. Obviously the only way of accomplishing this is to enclose the copper when heated and till cool in an atmosphere that can neither oxidise nor deoxidise copper. I find that by so doing copper may be heated to the melting point and allowed to cool again without suffering at all as regards its pitch. There are comparatively few gases that can be

\* *Scientific American.*

used for this purpose, but, fortunately, one which is exceedingly cheap and universally prevalent fulfills all requirements, viz., steam. In order to apply, then, in practice, the principles already enunciated, it is necessary only to anneal copper in the ordinary annealing pots, such as are used for iron; care being taken to enclose the copper while heating and while cooling in an atmosphere of steam. This will effectually exclude air and prevent the ingress of gases used in heating the annealer. Twenty-four hours may be used in the process, as in the annealing of iron wire, with no detriment to the wire. This may seem incredible to those manufacturers who have tried to anneal copper wire after the manner of annealing iron wire. By this method perfectly bright annealed wire may be produced. Such a process of annealing copper offers many advantages. It allows one to use a grade of copper that has hitherto been worked only at a great disadvantage, owing to the ease with which it gets out of pitch. It allows one to use annealers such as are ordinarily used for annealing iron, and thus cheapens the annealing considerably as compared with the present universal use of muffles. There is no chance of producing the overpoled condition from the action of reducing gases used in heating the muffles. There is no chance of producing the underpoled condition due to the absorption of suboxide of copper. None of the metal is lost as scale, and the saving that is thus effected amounts to a considerable percentage of the total value of the copper. The expense and time of cleaning are wholly saved. Incidentally bright annealed copper is produced by a process which is applicable to copper of any shape, size, or condition, a product that has hitherto been obtained only by processes (mostly secret) which are too cumbersome and too expensive for extensive use and, as is the case with at least one process with which the author is acquainted, with the danger of producing the over-

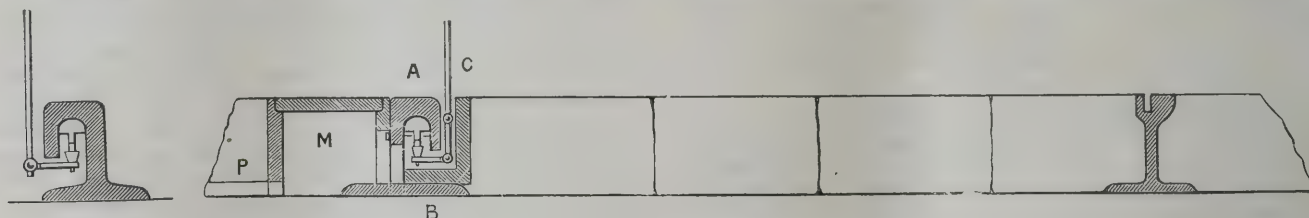


FIG. 2.

poled condition, often in only a small section of the wire, but thus ruining the whole piece.

If it is desired, the copper may be annealed in an apparatus so arranged that the copper when heated may be dropped into a body of water without access of air, and thus make a far smaller annealing plant suffice. It may be mentioned that copper seems to be made neither softer nor harder by being cooled suddenly in this manner than if cooled slowly, though some of the alloys of copper are rendered somewhat softer by a sudden cooling; in fact, there is not the slightest evidence anywhere to justify the quite prevalent belief that an art of hardening copper was known to the ancients. The hardest tools of the ancients were made of bronze, not copper.

By application of the same principles it is possible to prevent both deoxidation and oxidation in the heating of copper ingots for the rolls, and thus, by keeping copper at tough pitch all along, any copper that can be given tough pitch can be used for rolling as sheet copper or for wire.

I think it also practicable to produce bright copper rods direct from the rolls.

### PEDDIE'S CONDUIT RAIL.

THIS conduit rail is for use on tramways and railways worked by electricity. The conductor, properly insulated, is placed within the rail, thus avoiding the expense and inconvenience of a separate central conduit,

and the brush is applied to the underside. The wooden T-insulator (which is further itself insulated from the rail) is secured to the rail by a wooden dowell. The horizontal copper conductor is attached to the insulator by a kneed bracket, screwed to the insulator, the conductor being recessed so as to give a flush surface for the brush to travel over. Provision is made for points and crossings, and also for preventing the brush, &c., coming in contact with the rail. The slot in the rail answers both for wheel flange and also for the vertical conductor to the motor on the car. At suitable distances small iron cases, termed "mud traps," are placed opposite holes in the side of the rail. These permit of the rail being easily cleaned, and also of the renewal of the conductor without the permanent way being lifted. The rail can be flushed with water, and thus easily and effectively cleaned without affecting the conductor. It can also be easily applied to existing horse tramways.

The figs. show a cross section. A is the rail, with the conductor within it. C is the bracket (pendant from the car with motor) carrying the brush, which is applied to the underside of the conductor. M is the "mud trap" with movable cover, and pipe, P, to gutter. These pipes need only be at requisite distances, not at every "mud trap." Fig. 2 shows the arrangement for railways. In this case, the brush is applied from the outside instead of from the inside of the rail. The reason of this is, that in the case of railways, the pressure will be much greater than in the case of tramways. It is therefore desirable to have the body of the rail directly under the tread of wheel.

The object of the conduit rail is to provide a *simple, safe, and efficient* method of working electric tramways and railways, *at the least possible expense*, avoiding all the inconvenience and expense of costly central conduits, or poles and other overhead apparatus, for the

FIG. 1.

conductors. The following points have also been borne in mind:—

1. Placing the conductor where it will be safe from injury both to itself and the public.

2. Making provision for easily cleaning and flushing the rail without affecting the conductor within it. This is secured by means of the "mud traps," which at suitable points have pipes to the gutters.

3. Making provision for easily renewing the conductor when it is worn, without lifting permanent way. Thus, by removing the covers of the "mud traps," the brackets which hold the conductor to the T-insulator can be unscrewed, the conductor lowered, and then raised and removed through the slot. A new conductor can then be lowered and fixed in a similar manner. The T-insulators can also be removed and renewed by means of the "mud traps."

4. Making the rail suit for ordinary horse or steam or compressed air, or accumulator cars. As far as these cars are concerned, the "conduit rail" is practically an ordinary slot rail.

5. Avoiding any central slot rail (between the wheel rails), which is a great inconvenience to ordinary street traffic.

6. Making the system such that it can be easily and effectively, and without great cost, applied to existing tramways. This is done by simply lifting one of the ordinary slot rails and replacing it with a conduit rail with conductor. By doing this on short sections at night, all interruption of ordinary or car traffic is avoided.

7. General simplicity and freedom from liability to derangement.

**ELECTRICALLY-OPERATED TREVELYAN INSTRUMENTS WITH CARBON "ROCKERS" AND "BEARERS."**

By A. M. TANNER.

EVERYTHING concerning the genesis of the microphone and carbon telephone should be presented to the scientific and technical world, so that hereafter there shall be no further misconception as to the actual discoveries made by Prof. Hughes and Mr. Edison; the former having used hard carbon contacts in his microphone, and the latter having resorted to compressible, or soft carbon, in his original carbon telephone.

I have already shown, in an article which appeared in the *ELECTRICAL REVIEW* of August 22nd, that as far back as the year 1858 Rollman drew attention to the fact that a hard carbon prism resting loosely upon carbon bearer points included in a closed electric circuit will, by its vibratory movement produced by the passage of the electric current, serve to vary the points or surfaces of contact, and thus effect a change of tension of the electric current flowing in the circuit.

I now wish to call attention to another electrically-operated Trevelyan instrument, which has a carbon rocker vibrating upon carbon bearers.

In the London, Edinburgh, and Dublin *Philosophical Magazine* for 1859, Fourth Series, Vol. XVII., page 358, is an article by Prof. J. D. Forbes, of the University of Edinburgh, entitled, "Notes on Certain Vibrations Produced by Electricity." After reviewing prior experiments of Prof. Gore with a Trevelyan instrument having a hollow copper sphere, made to run on a circular track by the action of electricity. Prof. Forbes continues as follows, viz. :—

"I have obtained very active vibrations of carbon (such as is used in one of the elements of Bunsen's battery) resting upon brass, and also when it rests upon two pieces of carbon connected with the terminals of a battery. For this purpose, a battery having a certain amount of intensity is requisite, in order to overcome the resistance of carbon as a conductor, but the vibrations are most energetic. The extremely small expansion which takes place in carbon by heat is another argument against that view of the Trevelyan experiment."

The above-quoted description is not accompanied by an illustration, but from collateral evidence it undoubtedly warrants the sketch given below of the the arrangement of bearers and rocker.



It will readily be perceived how closely this resembles the "three-nail microphone of Prof. Hughes. I think it will be conceded that, in view of the instruments constructed by Rollman, Paalzow, and Forbes, the novelty of the microphone must be sought in the method of varying the force of an electric current by the action of sonorous vibrations; in other words, it appears almost impossible to uphold a claim for a microphone instrument in which a carbon electrode rests loosely upon another electrode, for the purpose of varying the tension of the current in a closed electric circuit in which said electrodes are included.

I believe it has been held by an English Court that "the circumambient air" is the equivalent of a diaphragm in a telephone, having a current tension regulator of carbon. If this is true, then the instruments of Rollman, Paalzow, and Forbes must have an exceedingly close bearing upon a microphone or carbon telephone whose novelty rests solely upon a variable contact rheostat of carbon, introduced into a closed

electric circuit. When it comes to the principle or method of operating the carbon rheostat by sonorous vibrations, then the Trevelyan instruments considered in my articles lose their pertinency. They can only be used to show that the device employed in a microphone (without a diaphragm) are old in other instruments, and that the action of a variable contact rheostat made of hard carbon, for changing the tension of the current in a closed electric circuit was discovered by Rollman.

**KEMMLER'S EXECUTION AS SEEN BY AN ELECTRICIAN.**

By CHARLES R. HUNTLEY.

IT is with pleasure that I comply with the request of the *Electrical World* to give my observations on the Kemmler electrocution. One of the prime reasons which prompted me to attend this event was that the electrical fraternity would have the benefit, so far as I was able to observe, of what occurred at this electrocution.

The dynamo, as is well known, is one of the Westinghouse type, the exciter being of the usual pattern sent with all dynamos of this make. It was located in the second story of the east wing of the prison, about 1,000 feet from the room wherein the death chair was located. The power was supplied by a 45 H.P. engine, belted to a 2-inch shaft, which ran through the dynamo room. On this shaft were a 36-inch pulley and a 30-inch pulley. From the 36-inch pulley was run an 8-inch belt down to a 12-inch pulley on the dynamo, and a 6-inch belt ran from the shaft to the exciter. No voltmeter or ammeter was connected up in circuit at this point. A resistance box was placed at the end, over the exciter. The wires led out through the window up over the roof on porcelain and glass insulators, down across and around the dome of the front of the prison; from there down on the wall into the window of what was known as the original room for the electrocution. This wire was of No. 12 B. and S. gauge, rubber covered, and said to have been made by the Edison Company. On the switchboards were two Cardew voltmeters, both connected up with resistance coils. Both were connected with switches, and between the two was a lamp board, which, I am told, is of the usual type used in the Edison stations. In this were 20 100-volt lamps of Edison make, and an ammeter of Bergman & Co.'s make was a part of the lower portion of the board.

There were two jaw switches—one known as the fatal switch and the other as the lamp board switch—which were placed on the wall of easy access to the executioner. From the board there ran wires of the same gauge into the chair, one being fastened to the electrode on the bottom, and the other to the electrode on the top. This is all of the electrical apparatus and distribution that I noted. A Mr. Davis was the man in charge. I might say that my curiosity prompted me to go with him to witness the first test of the machinery on Tuesday afternoon. Mr. Davis adjusted the brushes on both dynamo and exciter, and then left the apparatus in charge of three convicts who were assistants.

After going back to the switchboard signals were given to start up the dynamo. At that time the voltmeter showed about 1,000 volts. The lamps were in circuit and were about two-thirds candle-power. Again, in the evening, all of the witnesses summoned by law, together with the doctors and professional men, witnessed another test, which was substantially the same as that of the afternoon. There was no record taken of what the voltage was at that time, but an assumption was made that it was from 1,000 to 1,200 volts.

The morning of the execution came, and those who were to witness the first experiment upon human life by the electric current found, in a dimly lighted room,

the death chair, and around about the walls in a circle seats for their accommodation. I do not know that it will be of any interest to your electrical readers to record here (inasmuch as the Press has given all of that) what took place with reference to the in-coming of Kemmler and his spiritual advisers, but suffice to say that the man who stood before us exhibited the most unconcern of any of the 23 men who were within the room. After being strapped and pinioned to the chair, Kemmler assisting, and to quite an extent, the electrodes at the head and back were securely placed, the strap securely fastened over his face by the warden, the word was given to the three men who were in the room behind a closed door, and we witnessed the effect of the first contact by a contraction, or rather drawing up of his whole body within his bonds. The time by actual count was 17 seconds. The current then, by direction of Dr. Spitzka, was turned off, and to all appearances Kemmler was dead. As the doctor said: "There are unmistakable evidences of death about his nose, and I have never known such a condition as is demonstrated on this man except in death." One of the attendants then removed the electrode from his head, and those who were advocates of the killing by electricity were elated beyond expression. The look of entire satisfaction which spread over the countenances of some of the learned doctors was an indication of the joy that their labours had brought them in the death of Kemmler, apparently so painless and still. The next sound that was heard was of Dr. Spitzka saying: "This man is not dead. Turn on the current." The electrode, in a hurried manner, was again applied to his head, and the signals were sent out by one of the attendants in the room to start up the machinery. This was done. How soon I cannot say. The laymen were all in confusion at the horrible sounds that were coming from the man who had been pronounced dead. Words fail me with which to give you the faintest idea of what these were. There were men in that room who had witnessed executions and had seen death in various forms, but each and every one of them was horror stricken at this sudden change in the condition of the culprit. Various reports have been made as to the length of time of the second contact, but it has been my privilege to be associated somewhat with the gentleman who was in the dynamo room while the machine was in operation. He tells me that after the first shock the signals were given to shut down. This was done by the convicts. Then a short space—perhaps two minutes—and the signal was given to start again. Instantly another signal was given for more speed, and so on, until the dynamo was running, and as he stated, it was fairly jumping from the floor. I forgot to mention that during the time of the second shock the circuit was made and broken three times. At each of these periods the dynamo would be nearly stopped, and the belt after the first shock was nearly thrown off the dynamo pulley. Then a convict was instructed to hold the belt on each side of the pulley, which was done during the time that the dynamo was running, which was about three and a half minutes. Added to the horror of the sounds emitted by the so-called dead man, were what the doctors said were convulsions, but whatever it may be called, convulsions or not, I am told by one of the physicians, as reputable as any there, that life did exist in the man, though not sensibility, after the first shock. The electrode at his back had become loosened, admitting of arcing, and at this point of contact the flesh was literally roasted. The stench of burning flesh was almost unbearable to those of us unfamiliar with such things.

What occurred in the lamp room no one will ever know beyond the three persons present. I endeavoured to ascertain what the voltage was, but I did not succeed in getting any information, and I question very much whether Mr. Davis himself, who had charge of the electrical appliances, knows to what voltage Kemmler was exposed at either time.

From an electrical standpoint there was nothing gained to show what amount of current it takes to kill. No data of either the electrical or mechanical apparatus

was taken, and whoever assumes to say what the voltage was that Kemmler received must guess between 800 and 2,000.

#### MR. EDISON ON THE KEMMLER EXECUTION.

Mr. T. A. Edison, when interviewed, said: In December, 1887, I wrote to a man who asked for my views, that I would join heartily in a movement to abolish capital punishment. If it was not to be abolished, however, I said, we should adopt the quickest and least painful method of accomplishing it, and I believed an intermittent dynamo current properly applied would best meet these requirements. I still believe this. In the Kemmler execution, according to the reports printed in the newspapers, the fault rests upon the doctors. They acted upon theory, and knowing the base of the skull to be the nerve centre of the human system, they determined to reach it as directly as possible. Theoretically they were right, but practically they were wrong, as experience has demonstrated. In not a single one of the 30 perfect examples of the power of electricity to produce instant death that have occurred in and around New York was it applied to the head. Of what use has the death of these 30 men been? In every instance the fatal charge entered through the hands. In no case among these accidental deaths was the current that passed through the body one-half what it was announced was to be used on Kemmler. Electricity travels through fluids, and especially through the saline fluids of the body, much more freely than through bone. The hands, when cleansed and immersed in a solution of caustic soda, afford an excellent contact for electric currents, and as the fingers, hands and arms are full of blood, they make a good conductor of electricity. On the other hand, bone is one of the poorest conductors, and by making the points of contact on the thickest part of the skull, and the portion of the spine affording most resistance, the doctors invited a degree of failure. Neither contact could have been made in a less desirable place. The hair of the head is also a non-conductor, and offers resistance to electrical currents. If, as is stated, Kemmler's skin was burned at the points of contact, that proves that he received but a small portion of the charge. Had he received the full 1,300-volt current for the length of time stated, he would have been carbonised or mummified. If the report that 20 incandescent lamps were in the circuit and illuminated at the time the current was applied to Kemmler is true, the explanation is in part at least furnished. These lamps offer resistance to the flow of the current, and 20 of them would greatly reduce the potential of the current. They should have been removed from the circuit.

"How do you account for the muscular and apparently respiratory action after the current had been once turned on?" was asked. "Oh, I have no doubt he was dead," replied Mr. Edison. "I think the doctors will probably agree to that. You know there is often muscular movement after death by hanging. Kemmler was undoubtedly killed at the first, unless some big mistake was made. Undoubtedly all those present were greatly excited. I should have been excited myself at such a time. In that excitement there may have been some bungling. I think, when the next man is placed in the chair to suffer the death penalty, that death will be accomplished instantly and without the scene at Auburn."

**Proposed Electric Tramway at Plymouth.**—Arrangements are in progress for constructing a new tramway at Plymouth, and bringing the old lines, which have been for a considerable period in disuse, once more into working order. The work is to be carried out by Messrs. Grover & Co., and it is said to be the intention of the promoters of the new scheme to apply for the necessary powers to enable them eventually to use electricity as the motive power.

BRITISH ASSOCIATION FOR THE ADVANCE-  
MENT OF SCIENCE.—LEEDS, 1890.

THE sixtieth meeting of the Association opened at Leeds on Wednesday. A good many years have elapsed since the last meeting in this town, during which time the district, from a manufacturing point of view has greatly developed. There will probably not be a great number of electrical papers read at the meeting, but those promised bid fair to rank as valuable additions to technical literature.

On Wednesday evening Sir Frederick A. Abel, C.B., D.C.L., F.R.S., gave the presidential address, an abstract of which follows. Thursday was spent in hearing the addresses of the presidents of the various sections, and it will not be before to-day that they settle fairly down to work.

## ABSTRACT OF ADDRESS\*

BY SIR FREDERICK AUGUSTUS ABEL, C.B., D.C.L.  
(Oxon.), D.Sc. (Cant.), F.R.S., P.P.C.S., Hon.M.Inst.C.E.,  
*President.*

Among the branches of science in the practical applications of which the greatest strides have been made since the Association met at Leeds in 1858, is electricity. That year witnessed the accomplishment of the first great step towards the establishment of electrical communication between Europe and America, by the laying of a telegraph cable connecting Newfoundland with Valencia. Through this cable a message of 31 words was shortly afterwards transmitted in 35 minutes; an achievement which, though exciting great enthusiasm at the time, scarcely afforded promise of the succession of triumphs of ocean telegraphy which have since surpassed the wildest dreams of the pioneers in the realms of applied electricity.

The development of the electric telegraph constitutes a never-failing subject of the liveliest interest. The experiments made by Stephen Gray, in 1727, of transmitting electrical impulses through a wire 700 feet long; by Watson, 20 years afterwards, of transmitting frictional electricity through many thousand feet of wire, supported by a line of poles, on Shooter's Hill, in Kent; and by Franklin, who carried out a similar experiment at Philadelphia—although they were followed by many other interesting and philosophical applications of frictional electricity to the transmission of signals—were not productive of really practical results. The work of Galvani and of Volta was more fruitful of an approach to practical telegraphy in the hands of Sömmering and of Coxe, while the researches of Oersted, of Ampère, of Sturgeon, and of Ohm, and especially the discoveries of volta-electric induction and magneto-electricity by Faraday, paved the way for the development of the electric telegraph as a practical reality by Cooke and Wheatstone in 1837. How remarkable the strides have been in the resources and powers of the telegraphist since that time is demonstrated by a few such facts as these; the first needle instrument of Cooke and Wheatstone transmitted messages at the rate of four words per minute, requiring five wires for that purpose; six messages are now conveyed by one single wire, at ten times that speed, and news is despatched at the rate of 600 words per minute. Duplex working, which more than doubled the transmitting power of a submarine cable, was soon eclipsed by the application of Edison's quadruplex working, which has in its turn been surpassed by the multiplex system, whereby six messages may be sent independently, in either direction, on one wire. When last the British Association met in Leeds, submarine telegraphy had but just started into existence; 30 years later, the accomplished President of the Mechanical Section informed us, at our meeting at Bath, that 110,000 miles of cable had been laid by British ships, and that a fleet of nearly forty ships was occupied in various oceans in maintaining different cables and laying new ones.

The important practical achievements by which most formidable difficulties have been surmounted, step by step, in the successive attainment of the marvellous results of our day, have exerted an influence upon the advancement, not merely of electrical science, but also of science generally and of its applications, fully equal to that which they have exercised upon the development of commerce and of the intercourse between the nations of the earth.

Thus the laying of the earliest submarine cables between 1851 and 1855, led Sir W. Thomson, in conference with Sir George Stokes, to work out the theory of signalling in such cables, by utilising the mathematical results arrived at by Fourier in his investigation of the propagation of heat waves. The failure of the first Atlantic cable led to the survey of the bottom of the Atlantic, which was the forerunner of deep-sea explorations, culminating in the work of the *Challenger* expedition, and opening up new treasures of knowledge scarcely dreamt of when last the British Association met at Leeds. To the difficulties connected with the early attempts at submarine telegraphy, and the determination with which Thomson drove home the lessons learned, we owe the systematic investigations into the causes of the variations in resistance of copper conductors, and the consequent improvements in the metallurgy of copper, which led to the realisation of the high standard of purity of metal essential for the efficient working of telegraphic systems, and also to the extensive utilisation of

electricity in the production of pure copper. The rare combination of originality in powers of research and perspicuity in mathematical reasoning, with inventive and constructive genius, for which Thomson has so long been pre-eminent, has placed at the disposal of the investigator of electric science, and of the practical electrician, instruments of measurement and record which have been of incalculable value, and which owe their origin to the theoretical conclusions arrived at by him in his researches into the conditions to be fulfilled for the attainment of practical success in the construction and employment of submarine cables. The mirror galvanometer, the quadrant electrometer, the syphon-recorder, and the divided ring electrometer, are illustrations of the valuable outcome of Thomson's labours; the combination of the last-named instrument with sliding resistance coils has rendered possible the accurate sub-division of a potential difference into 10,000 equal parts. The general use of condensers in connection with cable signalling, due to Varley's application of them for signalling through submerged cables with induced short waves, was instrumental in establishing the fact that all electrostatic phenomena are simply the result of starting an electric current of known short duration round a closed circuit. The practical application of the Wheatstone bridge led to numerous important mathematical investigations, and induced Clerk Maxwell to devise a new mode of applying determinants to the solution of the complicated electrical problems connected with the networks of conductors. The necessity for the universal recognition of an electrical unit of resistance led to the establishment, in 1860, of the Electrical Standards Committee of the British Association, whose long succession of important annual reports was instrumental in most important developments of theoretical electricity, and, indeed, served to open up the whole science of electrical measurement. Matthiessen's important investigations of the electrical behaviour of metals and their alloys, and the preparation and properties of pure iron, were the outcome of the commercial demand for a practically useful standard of electrical resistance, while Latimer Clark's practical standard of electromotive force, the mercurous sulphate cell, became invaluable to the worker in pure electrical research. The unit of resistance established by the British Association Committee received, in 1866, most important scientific application at the hands of Joule, who, by measuring the rate of development of heat in a wire of known resistance by the passage of a known current, obtained a new value of the mechanical equivalent of heat. This value differed by about 1·3 per cent. from the most accurate results arrived at by his experiments on mechanical friction, a difference which eventually proved to be exactly the error in the British Association unit of resistance; so that the true value of the unit of resistance, or ohm, was determined by Joule 15 years before this result was achieved by electricians. Clerk Maxwell's remarkable electro-magnetic theory of light was put to the test, through the aid of the British Association unit of resistance, by Thomson, in determining the ratio of electro-magnetic unit to the electro-static unit of quantity. Many other most interesting illustrations might be given of the invaluable aid afforded to purely scientific research by the practical results of the development of electrical science, and of the constant co-operation between the science student and the practical worker. No one could, more fitly than the late Sir William Siemens, have maintained, as he did in his admirable address at our meeting in Southampton in 1882, that we owe most of the rapid progress of recent times to the man of science who partly devotes his energies to the solution of practical problems, and to the practitioner who finds relaxation in the prosecution of purely scientific enquiries. Most assuredly both these classes of the world's benefactors may, with equal right, lay claim to rank the name of Siemens among those whom they count most illustrious!

In that highly interesting and valuable address, delivered little more than a year before his sudden untimely removal from among us, the numerous important subjects discussed by him included not a few which he had made peculiarly his own in the wide range embraced by his enviable power of combining scientific research with practical work. Prominent among these were the applications of electric energy to lighting and heating purposes, and to the transmission of power, to the future development of which his personal labours very greatly contributed.

Siemens referred to the passing of the first Electric Lighting Bill, in the year of his presidency, as being designed to facilitate the establishment of electric installations in towns; but the anxiety of the Government of that day to protect the interests of the public through local authorities, led to the assignment of such power to these over the property of lighting companies, that the utilisation of electric lighting was actually delayed for a time by these legislative measures. There can now be no doubt, however, that this delay has really been in the interests of intending suppliers and of users of the electric light, as having afforded time for the further development of practical details, connected with generation and distribution, which was vital to the attainment of a fair measure of initial success. The subsequent important modification of legislation on the subject of electric lighting, together with the practical realisation of comparatively economical methods of distribution, the establishment of fairly equitable arrangements between the public and the lighting companies, and the apportionment, so far as the metropolis is concerned, of distinct areas of operation to different competing companies, have combined to place electric lighting in this country at length upon some approach to a really sound footing, and to give the required impetus to its extensive development. Nine companies either are now, or will very shortly be, actually at work supplying, from central stations, districts of London comprising almost the entire western

\* Only that portion of the Address relating to electrical matters has been abstracted.

and north-western portions of the metropolis. As regards other parts of England, there are already 27 lighting stations actually at work in different towns, besides others in course of establishment, and many more projected. The town of Leeds has not failed to give serious attention to the subject of utilising the electric light, and, although no general scheme has yet been adopted, the electricians who now visit this town will rejoice to see many of its public buildings provided with efficient electric illumination.

While the prediction made by Siemens, eight years ago, that electric lighting must take its place with us as a public illuminant, has thus been already, in a measure, fulfilled, important progress is being continuously made by the practical electrician in developing and perfecting the arrangements for the generation of the supply, its efficient distribution from centres, and its delivery to the consumer in a form in which it can be safely and conveniently dealt with and applied at an outlay which, even now, does not preclude a considerable section of the public from enjoying the decided advantages presented by electric lighting over illumination by coal-gas. Yet our recent progress in this direction, encouraging though it has been, is insignificant as compared with the strides made in the application of electric lighting in the United States, as may be gauged by the fact that, while in America the number of arc lamps in use, in April of this year, was 235,000, and of glow lamps about three millions, there are at present about one-tenth the number of the latter, and one hundredth the number of arc lamps, in operation in England.

In some important directions we may, however, lay claim to rank foremost in the application of the electric light; thus, our large passenger ships and our war ships are provided with efficient electrical illumination; to the active operations of our Navy the electric light has become an indispensable adjunct; and our system of coast defence, by artillery and submarine mines, is equally dependent, for its thorough efficiency, upon the applications of electricity in connection with range-finding, with the arrangement and explosion of mines, and with the important auxiliary in attack and defence, the electric light, which, while so arranged, at the operating stations, as to be protected against destruction by artillery-fire and difficult of detection by the enemy, is available at any moment for affording invaluable information and important assistance and protection.

Other important applications of the electric light, such as its use as a lighthouse illuminant, for the lighting of main roads in coal mines, where its value is being increasingly appreciated, and even for signalling purposes in mid-air, through the agency of captive balloons, are continually affording fresh demonstrations of the value of this particular branch of applied electric science.

At the Electrical Exhibition at Vienna, in 1883, where, not long before the lamented death of Siemens, I had the honour of serving as one of his colleagues in the representation of British interests, the progress which had been made in the construction of electrical measuring instruments since the French Exhibition and the Electrical Congress, two years before, was very considerable. The advance in this direction has been enormous since that time; but although the practical result of Thomson's and of Carlew's important work has been to supply us with trustworthy electrical balances and voltmeters, while efficient instruments have also been made by other well-known practical electricians, we have still to attain results in all respects satisfactory in these indispensable adjuncts to the commercial supply and utilisation of electric energy.

In connection with this important subject the recent completion of the Board of Trade standardising laboratory, established for the purposes of arriving at and maintaining the true values of electrical units, and of securing accuracy and uniformity in the manufacture of instruments supplied by the trade for electrical measurements, may be referred to with much satisfaction as a practical illustration of official recognition of the firm root which the domestic and industrial utilisation of electric energy has taken in this country.

The achievements of the telephone were referred to by Siemens in glowing terms eight years ago; but the results then attained were but indications of the direction in which telephonic intercommunication was destined speedily to become one of the most indispensable of present applications of electricity to the purposes of daily life. Preece, in speaking at Bath, two years ago, of the advances made in applied electricity, showed that the impediments to telephonic communication between great distances had been entirely overcome; and now, although considerably behind America and France in the use of the telephone, we are rapidly placing ourselves upon speaking terms with our friends throughout the United Kingdom. The operations of the National Telephone Company well illustrate our progress in telephonic intercommunication: that company has now 22,743 exchange lines, besides nearly 5,000 private lines, its exchanges number 272, and its call-offices 526. The number of instruments under rental in England has now reached 99,000; but, important as this figure is compared to our use of the telephone a very few years ago, it sinks into insignificance by the side of the number of instruments under rental in America, which at the beginning of the present year had reached 222,430, being an increase of 16,675 over the number in 1889. Only thirteen years have elapsed since the telephone was first exhibited as a practically workable apparatus to members of the British Association at the Plymouth meeting, and the number of instruments now at work throughout the world may be estimated as considerably exceeding a million.

The successful transmission of the electric current, and the

power of control now exercised over the character which electrically transmitted energy is made to assume, are not alone illustrated by the efficiency of the arrangements already developed for the supply of the electric light from central stations. Siemens dwelt upon this subject at Southampton with the ardent interest of one who had made its development one of the objects of his energetic labours in later years, and also with a prophet's prognostications of its future importance. In speaking of the electric current as having entered the lists in competition with compressed air, the hydraulic accumulator, and the quick running rope driven by water-power, Siemens pointed out that no further loss of power was involved in the transformation of electrical into mechanical energy than is due to friction, and to the heating of the conducting wires by the resistance they oppose, and showed that this loss, calculated upon data arrived at by Dr. John Hopkinson and by himself, amounted at the outside to 38 per cent. of the total energy. Subsequent careful researches by the Brothers Hopkinson have demonstrated that the actual loss is now much less than it was computed at in 1885; as much as 87 per cent. of the total energy transmitted being realisable at a distance, provided there be no loss in the connecting leads used.

The Paris Electric Exhibition of 1881 already afforded interesting illustrations of the performance of a variety of work by power electrically transmitted, including a short line of railway constructed by the firm of Siemens, which was a further development of the successful result already attained in Berlin by Werner Siemens in the same direction, and was, in its turn, surpassed by the considerably longer line worked by Messrs. Siemens at the Vienna Exhibition two years later. Various short lines which have since then been established by the firm of Siemens are well known, and one of the latest public acts in the valuable life of Siemens was to assist at the opening of the electric tramway at Portrush, in the installation of which he took an active part, and where the idea, so firmly rooted in his mind from the date of his visit to the Falls of Niagara, in 1876, of utilising water-power for electrical transmission—a result first achieved on a small scale by Lord Armstrong—was more practically realised than had yet been the case. Since that time Ireland has witnessed a further application of electricity to traction purposes, and of water-power to the provision of the required energy, in the working of the Bessbrook and Newry tramway, while London at length possesses an electric railway, three miles in length, to be very shortly opened, which will connect the City with one of the southern suburbs through a tram subway, and, although including many sharp curves and steep gradients, will be capable of conveying one hundred passengers at a time, at speeds varying from thirteen to twenty-four miles per hour. During the past year a regular service of tramcars has been successfully worked, through the agency of secondary batteries, upon part of one of the large tramways of North London, with results which bid fair to lead to an extensive development of this system of working. The application of electricity to traction purposes has, however, received far more important development in the United States; at the commencement of this year there were in operation in different States 200 electrical tramroads, chiefly worked upon the Thomson-Houston and the Sprague systems, and having a collective length of 1,641 miles, with 2,346 motor-cars travelling thereon. Further extensions are being rapidly made: thus, one company alone has 39 additional roads, of a collective length of 355 miles, under construction, to be worked through the agency of storage-batteries.

The idea cherished by Siemens, and enlarged upon by him in more than one interesting address, of utilising the power of Niagara, appears about to be realised, at any rate in part; as a large tract of land has been recently acquired, by a powerful American association, about a mile distant from the Falls, with a view to the erection of mills for utilising the power, which it is also proposed to transmit to distant towns; and an International Commission, with Sir William Thomson at its head, and with Mascart, Turrettini, Coleman Sellers, and Unwin as members, will carefully consider the problems involved in the execution of this grand scheme.

The application of electric traction to water-traffic, first successfully demonstrated in 1883, is receiving gradual development, as illustrated by the considerable number of pleasure-boats which may now be seen on the Upper Thames during the boating season, and in connection with which Professor George Forbes proposed, at our meeting last year, that stations for charging the requisite cells, through the agency of water-power, should be established at the many weirs along the river, so as to provide convenient electric coaling-stations for the river pleasure-fleet.

Electrically-transmitted energy was first applied in Germany to haulage work in mines by the firm of Siemens some years ago, and great progress has since been achieved herein on the Continent and in America. Comparatively little has been accomplished in this direction in England; but it is very interesting to note, on the present occasion, that the first successful practical application of electricity in this country to pumping and underground haulage-work was made in 1887, in this neighbourhood, at the St. John's Colliery, at Normanton, where an extensive installation, carried out by Mr. Immisch, so well known in connection with electric launches, is furnishing very satisfactory results in point of economy and efficiency. The gigantic installations existing for the same purposes in Nevada and California afford remarkable illustrations of the work to be accomplished in the future by electrically-transmitted energy.

Among the many subjects of importance studied by Joule with the originality and thoroughness characteristic of his work, was the application of voltaic electricity to the welding and fusion of

metals. Thirty-four years ago he published a most suggestive paper on the subject, in which, after dealing with the difficulties attending the operation of welding, and of the interference of films of oxide, formed upon the highly heated iron surfaces, with the production of perfect welds either under the hammer or by the methods of pressure (of which he then predicted the application to large masses of forged iron), he refers to the possibility of applying the calorific agency of the electric current to the welding of metals, and describes an operation witnessed by him in the laboratory of his fellow-labourer, Thomson, of fusing together a bundle of iron wires by transmitting through them, when imbedded in charcoal, a powerful voltaic current. Joule afterwards succeeded in fusing together a number of iron wires with the current of a Daniell battery, and of welding together wires of brass and steel, platinum and iron, &c. In discussing the question of the amount of zinc consumed in a battery for raising a given amount of iron to the temperature of fusion, he points out that the same object would probably be more economically attained by the use of a magneto-electric machine, which would allow the heat to be provided by the expenditure of mechanical force, developed in the first instance by the expenditure of heat; and he indicates the possibility of arranging machinery to produce electric currents which shall evolve one-tenth of the total heat due to the combustion of the coal used, so that 5,000 grains of coal applied through that agency would suffice for the fusion of one pound of iron. The successful practical realisation of Joule's predictions in regard to the application of electric currents, thus developed, to the welding of iron and steel, and to analogous operations, through the agency of the efficient machines devised by Prof. Elihu Thomson, was demonstrated to the members of the Association by Prof. Ayrton at Bath two years ago, and was shown upon a larger scale to visitors at the Paris Exhibition last year, and recently to highly-interested audiences in London by our late President, Sir Frederick Bramwell. The latter demonstrated that the production of iron welds by means of the Thomson machines was accomplished nearly twice as rapidly as by expert craftsmen; the perfection of the welds being proved by the fact that the strength of bars broken by tensile strains at the welds themselves was about 92 per cent. of the strength of the solid metal. At the Crewe Works, Mr. Webb is successfully applying one of these machines to a variety of welding work. The rapidity with which masses of metal of various dimensions are raised in those machines to welding heat is quite under control; the heat is applied without the advent of any impurities, as from fuel, and the speed of execution of the welding operation reduces to a minimum the time during which the heated surfaces are liable to oxidise. With such practical advantages as these, this system of electric welding bids fair to receive many useful applications.

Another very simple system of electric welding, especially applicable to thin iron and steel sheets, hoops, &c., has been contemporaneously elaborated in Russia by Dr. Bernadov, and is already being extensively used. The required heat at the surfaces to be welded is developed by connecting the metal with the negative pole of the dynamo machine, or of a battery of accumulators, the circuit being completed by applying a carbon electrode to the parts to be heated; the reducing power of the carbon is said to preserve the heated metal surfaces from oxidation during the very brief period of heating. This mode of operation appears to have been practised upon a small scale, some years ago, by Sir William Siemens, to whom we also owe the first attempt to practically apply electric energy to the smelting of metals.

In his address in 1882 he referred to some results attained with his small electrical furnace, and pointed out that, although electric energy could, obviously, not compete economically with the direct combustion of fuel for the production of ordinary degrees of heat, the electric furnace would probably receive advantageous application for the attainment of temperatures exceeding the limits (about 1,800° C.) beyond which combustion was known to proceed very sluggishly. This prediction appears to have been already realised through the important labours of Messrs. Cowles, who some years ago attacked the subject of the application of electricity to the achievement of metallurgic operations with the characteristic vigour and fertility of resource of our Transatlantic brethren. After very promising preliminary experiments, they succeeded, in 1885, at Cleveland, Ohio, in maturing a method of operation for the production of aluminium bronze, ferro-aluminium and silicon-bronze, with results so satisfactory as to lead to the erection of extensive works at Lockport, N.Y., where three dynamo machines, each supplying a current of about 3,000 amperes, are worked by water power, through the agency of turbines, each of 500 H.P., 18 electric furnaces being now in operation for the production of aluminium alloys. These achievements have led to the establishment of similar works in North Staffordshire, where a gigantic dynamo machine has been erected, furnishing a current of 5,000 amperes, with an E.M.F. of 50 to 60 volts. The arrangement of the electrodes in the furnaces, the preparation of the furnace charges (consisting of mixtures of aluminium ore, with charcoal and with the particular granulated metal with which the aluminium is to become alloyed at the moment of its elimination from the ore); the appliances for securing safety in dealing with the current from the huge dynamo machine, and many other details connected with this new system of metallurgic work, possess great interest. Various valuable copper and aluminium alloys are now produced by alloying copper itself with definite proportions of the copper alloy, very rich in aluminium, which is the product of the electric furnace. The rapid production in large quantities of ferro-aluminium—which

presents the aluminium in a form suitable for addition in definite proportions to fluid cast iron and steel—is another useful outcome of the practical development of the electric furnace by Messrs. Cowles.

Great interest attaches to the influence of the metals manganese, chromium, and tungsten upon the physical properties of steel and iron.

The curious effect of manganese in reducing, and even destroying, the magnetic properties of iron was already noticed by Rinnman nearly 120 years ago; one result of Hadfield's important labours has been to place in the hands of such eminent physicists as Thomson, John Hopkinson, and Reinold, materials for the attainment of most interesting information respecting the electrical and other physical characteristics of manganese steel. Hopkinson, from experiments with a sample of steel containing 12 per cent. of manganese, estimated that not more than 9 out of the 86 per cent. of the iron composing the mass was magnetic, and he considered that the manganese enters into that which must, for magnetic purposes, be regarded as the molecule of iron, completely changing its properties, a fact which must have great significance in any theory regarding the nature of magnetisation.

## NEW PATENTS—1890.

12532. "Improvements in electric lighting." S. PITT. (Communicated by Sautter Harlé and Co., France.) Dated August 11. (Complete.)

12628. "Improvements relating to the welding of metals by electricity." H. E. FOWLER. Dated August 12. (Complete.)

12634. "Improvements in dynamo-electric machines or electric motors." T. M. FOOTE. Dated August 12. (Complete.)

12713. "Improvements in electric mains, and in apparatus used in their manufacture." S. Z. DE FERRANTI. Dated August 13.

12819. "Improvements in column type printing instruments operated electrically, for telegraphic and other purposes, and in conductors therefor, which latter also applicable for telephonic and electric transmission generally." S. D. WILLIAMS. Dated August 15.

12827. "Improvements in armatures for dynamo-electric machines." H. J. HILTON. Dated August 15.

12830. "Improvements in secondary batteries, and electrodes therefor." H. H. LAKE. (Communicated by G. A. Johnson and S. L. Holdredge, United States.) Dated August 15. (Complete.)

12832. "An electrical watt meter, also applicable as an ammeter or voltmeter." E. WILSON. Dated August 15.

12874. "Improved electric switch." C. R. BONNE. (Communicated by The Actien Gesellschaft Mix and Genest, Germany.) Dated August 16.

12914. "Improvements in switches for controlling and regulating double or compound electric motors, especially applicable to traction or marine propulsion." A. J. JARMAN. Dated August 18.

12915. "Improvements in brush holders for dynamo-electric motors and generators." A. J. JARMAN. Dated August 18.

12958. "Improvements in apparatus for effecting, by insertion of a coin, the production of electric light for a certain time." D. H. DAVIES and J. M. TOURTEL. Dated August 18.

12997. "An improved electrical rock drill, coal digger, or earth cutter." W. B. BRAIN, A. J. ARNOT, and F. BAKER. Dated August 19. (Complete.)

13002. "Improvements relating to induction coils or transformers chiefly designed for use in welding or otherwise working metal by electricity." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated August 19. (Complete.)

13003. "Improvements in the manufacture of electrodes for primary and secondary batteries." D. PEPPER, jun. Dated August 19. (Complete.)

13006. "Improvements in welding or otherwise working metals by electricity, and in apparatus therefor." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated August 19. (Complete.)

13009. "Improvements in printing telegraphs." J. B. ODELL. Dated August 19. (Complete.)

13013. "Improvements in the manufacture of electrodes for primary and secondary batteries." D. PEPPER, jun. Dated August 19. (Complete.)

13042. "Improvements in or appertaining to electric railway systems." C. J. VAN DEPOELE. Dated August 19. (Complete.)

13044. "A new or improved method and apparatus for effecting economy of electric force in electric writing." P. E. BARDONNAUT and P. JUPPONT. Dated August 19. (Complete.) [Date applied for under Patents Act, 1883, Sec. 103, 20th February, 1890, being date of application in France.]

13049. "Improvements in electric telegraphs, in part applicable for signalling on racecourses and elsewhere." F. E. MACMAHON. Dated August 19.

13129. "Improvements in safety fuses or cut-outs for electric circuits." A. W. SLATER. Dated August 21.

13164. "Improvements in means and apparatus for adjusting electric suspending lights, and for other like purposes." A. LUCAS and E. SUNDBORG. Dated August 21.

13171. "Improvements in fittings for incandescent electric lamps." L. HOEPL and E. COURTIN. Dated August 21.

13175. "Improvements in miners' electric safety lamps." W. PETO. Dated August 21.

13187. "Improvements in electro-motors." R. F. MOORE. Dated August 21. (Complete.)

13190. "Improvements in exciting electro-magnets and electro-magnetic machinery." R. KENNEDY. Dated August 22. (Complete.)

13212. "Improvements in electric accumulators." R. DRYSDALE. Dated August 22.

13233. "Improvements in portable electric lamps, more especially intended for miners' use." THE MINING AND GENERAL ELECTRIC LAMP COMPANY, LIMITED, and W. MOSCROP. Dated August 22. (Complete.)

13276. "Improvements in covering wires to protect them from corrosion, especially applicable to electrical conductors." E. SHIN. Dated August 23.

13282. "Improvements in electric lamps, and means for securing electric lamps in carriages and like vehicles." G. F. SLATTER. Dated August 22. 8d. Claims:—1. Supporting the platinum wires and the filament of an incandescent electric lamp from within the lamp, said support being independent of the usual end support as set forth. 2. The double suspension appliances of an electric incandescent lamp and of its attachments as means for subduing vibrations of the lamp and for preventing oscillation of the filament as set forth. 3. Fixing an India-rubber sheet web and attaching an incandescent electric lamp frame thereto as a means for suspending an electric incandescent lamp in or from a carriage as and for the purposes set forth.

13338. "Improvements in means or devices for use in the distribution of electrical currents." A. W. HEAVISIDE and R. C. JACKSON. Dated September 2. 8d. The objects of the invention are to provide devices which furnish adequate means for localising faults in underground mains, and give protection to the mains and submains from over pressure by means of fuses conveniently situated at the distributing points. The invention also gives great facilities for insulating joints in mains so that the insulation need not be disturbed each time a test has to be made and further also facilities for cross connecting mains so as to make a good main relieve a defective one, or to alter the distribution of electric energy so as to meet varying needs. 10 claims.

14086. "Improved means for effecting the insulation of electrical transformers, switches, switchboards, fuses, commutators, and commutator brushes." W. C. JOHNSON and S. E. PHILLIPS. Dated September 6. 8d. Has mainly for its object to obtain a better insulation of electrical transformers, switches, switchboards, fuses, commutators and their brushes, and it consists in immersing these apparatus in, or surrounding them by, a non-conducting liquid, such as mineral oil, or other suitable liquid whereby they are protected from the atmosphere, and at the same time sparks that may be produced are immediately extinguished, and any tendency to form an arc is greatly lessened. 1 claim.

### ABSTRACTS

#### OF PUBLISHED SPECIFICATIONS, 1889

11032. "Improvements in electric meters." J. OULTON and J. EDMONDSON. Dated July 9. 8d. Consists in the mode of regulating the time of rotation of "torsion balances" in electric meters. The inventors attach the torsion ribbon (by which such balances are suspended) to the stem of a screw, or to a lever by which it is raised or lowered through a curb, such raising or lowering shortens or lengthens the acting portion of the ribbon and thus increases or lessens the speed of rotation as may be required. 7 claims.

11419. "Improvements in electric meters." SIEMENS BROTHERS & Co. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 16. 8d. The apparatus consists essentially of a light arm or lever having a suitably curved face which is caused by clockwork to be turned on its axis at regular intervals of time from a stated rest until it meets the end of a pointer, the position of which is determined by the strength of the current, such angular motion of the arm being transmitted to the wheel work of a counter or registering mechanism. 6 claims.

11425. "Improvements in regulating apparatus for electric arc light lamps." E. FISCHINGER. Dated July 16. 8d. Two electro-magnets are employed, the winding of which magnets is made of fine wire, in derivation from, or parallel to the main circuit, and in combination with these electro-magnets, mechanical devices are employed, by which the armatures of the said electro-magnets will cause the approach of the two carbons for making contact, the separation of the carbons for creating the arc, and the regulation of the position of the two carbons relatively to each other in a quiet and accurate manner. 1 claim.

11519. "Improvements in roses for supporting electric lamps." C. W. FARQUHAR and H. L. DOULTON. Dated July 18. 6d. The inventors make roses for supporting electric lamps in three pieces, A, B, and C. The piece, A, is cemented, screwed or otherwise fixed to the ceiling or wall from which the lamp is to be supported. At the centre it is provided with a projection of a disc like form with a screw thread around its edge. This disc is perforated for the leads to be passed through. The piece B rests against A; it is also perforated to receive the conductors attached to the lamp. The junctions between these and the leads are made between the pieces A and B and are thus concealed. The piece, C, consists of a screw cap which screws on to the piece A, and holds the piece B in position. 2 claims.

11997. "Improvements in electric meters." W. EMMOTT and W. ACKROYD. Dated July 29. 6d. A receiver over the electrodes and dipping into the electrolyte is connected with a closed vessel containing liquid. This closed vessel communicates with the outside by means of a safety tube dipping into the liquid, and is also provided preferably with a syphon. Each time a given amount of gas is liberated by electrolysis, the liquid in the closed vessel is forced up the syphon and also up the safety tube until the bottom of the safety tube is exposed when a quantity of gas is at intervals forced out of the safety tube. The force of this escape is utilised to measure the amount of electricity by means of a mechanical or other suitable device. 2 claims.

13149. "Improvements in apparatus for obtaining reciprocating motion from electric currents, applicable to the operation of electric bells, hammers, caulking tools or the like." T. PARKER. Dated August 20. 6d. The inventor includes in the operating circuit a pair of coils, or their equivalents, by which the hammer, or part to be reciprocated, is moved alternately in opposite directions, the said hammer or part acting upon a switch with scraping or rubbing contacts so arranged that after the reciprocating hammer or moving part is attracted in one direction it causes the switch to make contacts to break the circuit to the coil which attracted the hammer or moving part and complete the circuit through the opposite coil, and so on during the operation of the device. 3 claims.

### CORRESPONDENCE.

#### Cable Testing.

In 1884 I had occasion to use some quick method of finding weak places and bad faults in electric light cables having very heavy conductors, such as strands of 19 No. 6 wires, weighing nearly 12,000 lbs. per mile. My method was as follows:—

Put a drum with a cable coiled on it on an insulated stand, fastening the inside end of the cable to the spindle on which the drum revolves so that there is good rubbing contact, take the outside end to another drum a few feet away also insulated. Now, attach one end of a battery of 300 Leclanché cells to the spindle of the full drum, the other end being "to earth." Having done this, take a man (one peaceably inclined for preference), put a piece of wet cotton-waste in his hand and let him grasp the cable (which must be hauled from the full drum on to the empty one by an insulated man) so that every inch passes through his hand; when the fault comes, if you pick out a nice damp place for the uninsulated man to stand on, he will let you know at once without previous instructions. I had to forego this method owing to a scarcity of the proper sort of men in our locality.

I then tried placing a shunted reflecting galvanometer in the circuit, putting the man on insulators, and this acted perfectly. The especial merit of the above method is, that in the case of a hemp braided cable, such as I was manufacturing then, there is no need to cut the braiding and tapings except at the exact spot where the fault lies; of course the external coverings of the cable must be moderately dry.

Basil Gee,

Late Works Manager and Electrician to  
Callender's Company, Limited.

#### Fusible Cut-Outs in Armatures.

Can any of your readers kindly inform me of any instance where fusible wire has been used in connecting the sections of a gramme armature to the segments of the commutator, the connecting wire acting as a fusible cut-out in case of two segments of the commutator becoming short circuited.

E. J. M.

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ELECTRICAL HETERODOXY.

THE leading lights in the science of electricity have, in recent years, made notable progress in the field of electrical theory. Faraday first drew attention to the important part played by the dielectric in all electrical phenomena; and his epoch-making discoveries afterwards received their full mathematical interpretation from the genius of Clerk Maxwell. Some of the remarkable results of Maxwell's investigations have received experimental proof by the labours of Hertz and others. Further developments of theory have been made by Thomson, Poynting, Lodge, and others of Maxwell's school.

In science, as in politics, there is a danger that a great leader may prove the evil genius of his followers, and hence the advantage of a little healthy dissent. Mr. James Johnstone, of Edinburgh, is a prominent member of the class who refuse to accept the recent developments of electrical theory. He is no novice in the study of electricity, for he seceded from the orthodox school more than fifty years ago, differing from Faraday on his theory of induction by polarisation of the atoms of the dielectric, and claiming to have converted him by a letter, sent to him in 1839, to the belief that electricity passes through glass by conduction and not by induction. Mr. Johnstone has expounded his views in two pamphlets, one entitled "The Ether Theory of 1839 is the True Theory of the Leyden Jar," and another entitled "Facts which prove that Faraday's Two Force Theory of Electricity is False." We have also had the privilege of seeing Mr. Johnstone's experiments at his laboratory at Dalhousie Terrace, Edinburgh, and some of these are sufficiently remarkable to be of great interest to electricians. Mr. Johnstone's theory of the Leyden jar differs considerably from that which is generally accepted. In his opinion, *induction* is a myth, and electricity will pass by *conduction* through glass of the best insulating quality. He considers that by his experiments he has proved that in charging a

Leyden jar, electricity passes at first by *conduction*, through the glass, "but the moment the electricity begins to pass by *conduction* through the glass, it immediately acts on the particles of the glass, by increasing their attraction, so far that it has the effect of stopping the passage of the current of electricity through the glass to a slight extent, but the current goes on by conduction at a diminished rate until the increased attraction of cohesion of the glass entirely stops the passage of the electricity." In proof of this thesis, Mr. Johnstone offers the following experiments:—A test tube about 8 inches long and 1 inch in diameter, without any extra thickness of glass at the closed end of the tube, or other imperfection, is slipped on the positive electrode of an influence machine, so that the terminal ball reaches close up to, but does not touch the inner end of the tube; and the ball of the negative terminal is brought within a quarter of an inch of the outside bulb of the tube. On turning the machine, sparks are seen to pass from one terminal of the machine to the other, through the substance of the glass, and on examination the tube will be found to be quite free from perforations. This unexpected result can easily be obtained by anyone who chooses to repeat the experiment. In another experiment Mr. Johnstone sends positive sparks into a Leyden jar, supported horizontally on insulating pillars, and having a break in the wire connecting the outer coating to the earth. The direction of the current in the sparks entering the inner coating and leaving the outer coating of the Leyden jar are indicated by insulated gas flames placed in the path of the sparks. It was discovered by Mr. Johnstone in 1839 that these flames are deflected in the direction in which so-called positive electricity is passing. At the commencement of the charging, positive electricity is found to leave the outer coating apparently at the same rate as it enters the inner coating, but at the end of the operation the discharge from the outer coating gradually falls off and finally ceases. If a wire is passed through the stopper of the jar, so that part of the wire passes into the interior of the jar,

while the outer end is pointed and bent at right angles till the point projects over the edge of the jar. Mr. Johnstone finds that as long as positive electricity is passed into the interior of the jar, positive electricity continues to leave the outer coating. This does not stop as in the former case, but may be continued for any length of time.

Now, do these experiments necessarily prove that electricity passes through glass by *conduction*, and that *induction* is a myth? With all respect to Mr. Johnstone, we think not. The experiment with the test tube is a remarkable one, and it will be new to most electricians to see the electrical spark apparently passed through glass without perforating it. We have ourselves repeated the experiment, and we believe that the following explanation is correct. In the case of all the test tubes we have experimented with we have found that even when thoroughly dried they are comparatively good conductors for the electric spark from an influence machine. Hence, in the experiment described above, when the spark from the positive electrode of the influence machine strikes the interior of the test tube, an equal quantity of electricity must leave the outer coating; just as when a billiard ball strikes one of two billiard balls lying in contact the outer ball will be driven off without apparently producing any movement in the ball which was struck. The charge imparted to the inner surface of the test tube is now quickly dissipated by conduction, and the interior of the tube is ready to receive another spark with exactly similar results. In the case of a Leyden jar with glass of good insulating quality the first spark of electricity imparted to the inner coating will cause a similar spark to leave the outer coating, but the second, third, or some succeeding spark will cause a spark to leap from the inner to the outer coating, through the mouth of the jar if the jar is open mouthed. This last result, it appears to us, completely explains the action of Mr. Johnstone's pointed wire. The wire being a conductor and pointed, reduces the resistance of the path between the inner and outer coatings of the jar, and permits the electricity to flow between them, even when the potential is much below its maximum with the ordinary arrangement of the jar.

Mr. Johnstone, in his book, also discusses the classical experiment employed to show the phenomenon of electrostatic induction, in which an insulating conducting cylinder is placed with one end near to a conductor charged with electricity. He found by his insulating flame that a current of electricity was passing through the air space between the two conductors, and his explanation of the phenomenon is that a current is continually flowing along the line of conductors, which current is dammed back, as it were, by the greater resistance of the air, and appears as a charge of positive electricity at one end of the insulated cylinder. We have not been able to make any experiments to confirm Mr. Johnstone's statement as to the passage of electricity through the dielectric air, but at least in one of his deductions, namely, that the potential is greater at one end of the cylinder than at the other,

he is wrong. He may easily convince himself of this by connecting the opposite ends of the cylinder to the two poles of a quadrant electrometer.

We think that Mr. Johnstone is right in his view that there is only one kind of electricity, the so-called negative electricity being due to a diminution of the normal charge. Whether or not he is right in his view that electricity is matter, depends greatly on what definition of matter he adopts. It is impossible also, we think, to prove that he is wrong in supposing that, under certain conditions, electricity (if it is a substance) passes through the substance of a dielectric. All that is necessary, however, to support the modern theory of induction is, that during its passage it stores up the whole of its energy in an elastic dielectric in such a way that the dielectric has the power of restoring it more or less completely to the electricity during discharge. The controversy as to whether induction is real or imaginary, appears to us to resolve itself into a logomachy.

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## ELECTRICAL STANDARDS.

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THE necessity for determining accurately the value of the electrical standards is growing day by day, and it seems time that energetic steps were adopted to have the matter taken in hand. The work of carrying out the determination is by no means easy, but so many practical suggestions have been put forward, and so many preliminary experiments made by various workers, that the chances of obtaining reliable results are vastly greater than they were a few years ago. Some time since, Lord Rayleigh advocated certain work which he considered necessary to be done before the conditions for an accurate determination of the value of the ohm could be advantageously discussed. This work, at least one of the papers read before the British Association, stated had been accomplished, and therefore, in view of the practical necessity for an authoritative determination having arisen in connection with the standardising laboratory, the author thought the time ripe for the whole matter to be dealt with. In view of the extreme importance of the subject, it seems reasonable that a Government grant should be obtained for the purpose, and this would, we believe, be largely supplemented by the free-will offerings and labour of those interested. In view of the fact that the adoption of a correct standard is an international matter, it is of great importance that the work be carried out in this country as thoroughly as possible, no expense being spared to effect the required object in a manner which shall disarm criticism. If this is not done, we shall be liable to have the results questioned by others who have been privately working, and who may claim that they have arrived at their determinations by methods and with apparatus equally efficient with those employed by our own scientists. In fact, we believe that it was some such argument as this which led to the absurdity known as the legal ohm, which, however, fortunately never came into actual use.

Waste in  
Transformers.

SIR WILLIAM THOMSON'S B.A. paper on Anti-effective Copper in Conductors is not only of scientific interest, but has, in addition, great practical value. The author shows that though the ohmic resistance of a conductor may be reduced as its cross section is increased, a thickness is soon reached at which, notwithstanding the reduction of the ohmic resistance, an addition of copper causes an increase in the heat generated by an alternating current in the conductor. This results from an unequal distribution of the current throughout the cross section of the conductor which is caused by parasitic currents generated inductively in its mass. After a certain point, then, not only does increasing the copper fail to give an advantage, but it is productive of actual loss, or becomes, as Sir W. Thomson puts it, anti-effective. These considerations are specially applicable to the case of coils consisting of several layers of wire laid above each other in series, as in the various forms of transformers; but the author shows that a remedy for the evil indicated may be found in employing a stranded conductor which has its separate wires insulated from each other by a slight coating of varnish or other suitable material. In his paper on Alternate Currents in Parallel Conductors, Sir William Thomson considers the effective resistance offered by conductors to alternating currents or rapid discharges of electricity.

Permanent Magnets.

MR. PREECE'S interesting paper "On the Character of Steel used for Permanent Magnets," gives the results of a large number of experiments on magnet steel made at the Post Office. It will be seen from the figures that the French specimens are much superior to those supplied by English makers, as far as strength is concerned; at the same time it is possible that in the former the magnetism may be less permanent, and we believe we are correct in saying, that in instrument work, permanence is of quite as much importance as strength. We are pleased to note that Mr. Preece means to further investigate the matter, when the point to which we have referred will doubtless receive full attention.

Effect of Electricity on  
the Human Body.

MESSRS. LAWRENCE AND HARRIES have supplemented their paper read before the Institution of Electrical Engineers, by one read at the B.A. meeting, in which further experiments are recorded. This time they used the currents from actual lighting circuits, and obtained results widely different from those given in their previous paper. The figures given in Table C, showing the variation in the strength of the current with the contact area, seem very extraordinary, and demand further elucidation. That there is a relation of some kind is undeniable, but from the readings it seems impossible to formulate any definite law respecting it. The paper and the conclusions at which its authors arrive are before our readers, who can, themselves, extract from it such information as they think may be of service. The main conclusions are that an alternating current of 100 volts sends through an ordinary individual, touching the poles with his hands, a current which produces muscular fixation, thus depriving him of the power to release himself, while by a direct current no such

effect is produced. The obvious moral is—Don't touch the poles at all, advice which most users of electricity will be pleased to take.

Electrical Exhibits  
for 1893.

THE National Electric Light Association held its twelfth convention at Cape May and deliberated upon topics of common interest to the electrical fraternity. As usual, many of the questions under discussion were more or less of local importance, but those which may claim universal attention were by no means plentiful. Prof. John P. Barrett read a paper on "Electrical Industries and the World's Fair," setting forth the deficiencies in matters of electrical exhibits at the Paris Exhibition of 1889, and he exhorted his hearers to make the utmost effort for a gigantic display of American electrical machinery at the proposed great exhibition of 1893, to be held at Chicago. At the present time there are in the United States some 430 separate companies and individuals who may be expected to apply for space, but everyone of this number will probably defer action until the last possible moment, unless the importance of securing the necessary space and having the exhibit in readiness within the appointed time, is impressed upon them. Some of the manufacturers will have to be coaxed into making exhibits, while others will hesitate on account of the expense entailed. The author criticised the methods adopted at Paris and other exhibitions, and suggested that exhibits should be arranged according to the various types of apparatus, irrespective of the main display of the exhibitor. That is, to place all telephone apparatus and everything thereto appertaining in close proximity; the same with telegraphic apparatus, arc lighting dynamos, incandescent machines, motors, &c. The carrying out of such a plan will, of course, give two or more separate exhibits to each manufacturer, and thus entail additional expense, both in the matter of suitable furniture, and possibly in the matter of attendance; but all this additional outlay would be more than returned in the excellent results attained, and in the simplifying of the study of any particular type of apparatus. This suggestion has scarcely the merit of novelty; at English exhibitions, especially those of an engineering character, this method of grouping allied subjects has frequently been carried out as far as it was possible to do so.

Prevention of  
Accidents from  
Electric Currents.

"WHEN the development of electric currents, on a large scale and at small cost, first became possible by reason of recent discoveries, the question of the dangers to life and property attending their use was brought prominently before the public, just as the dangers attending the use of steam, of rapid locomotion on railroads, and of dynamite were brought to the attention of the world when these powerful agencies first left the experimental laboratory of the chemist or engineer to take their part in the ordinary labour and business of life." With these words Prof. Henry Morton opens a paper on "The Dangers of Electricity." He maintains that a much smaller number of people are killed or injured by high pressure boilers than by low pressure ones; the same relation has been found between dynamite and gunpowder, the former having largely reduced the proportion of accidents and injury as compared with the work done. Without these "dangerous" agencies

man would be reduced to the lowest condition of savagery, when he would be at all times helplessly at the mercy of the "elements," or the blind forces of nature. Referring to accidents from high tension currents, the author states that the "Employer's Liability Assurance Corporation" had collected a mass of material from a great variety of sources, and it has formulated a series of rules for the protection of those employed in erecting and operating electric apparatus involving the use of dangerous currents. These rules have been examined and approved by several prominent electric companies, and so far it would appear as if no accidents have resulted from the use of electric currents where these rules have been followed, and that most, if not all, the accidents which have occurred would have been prevented had these rules been obeyed.

#### Secondary Cells.

IN his concise paper before the British Association, Mr. Barber Starkey sets forth the history of his discovery of the effect of carbonate of soda upon the sulphate in lead sulphuric acid cells. We have repeatedly referred to this subject in our columns, and need only mention now the present statement of Mr. Barber Starkey, which is to the effect that according to his experience it is no longer necessary to pass a heavy current through cells to prevent sulphating, and he suggests that it would be more satisfactory to use larger cells than has hitherto been customary for stationary work, and both charge and discharge them at a considerably lower rate than at present recommended, thereby enormously increasing the life and efficiency of the cells, and leaving a large surplus in case of emergency. His own cells have been treated in this way, and they have not materially deteriorated after nearly five years' use. The author also recommends the use of soft lead grids in preference to those of a hard and brittle alloy. The desirability of this we were the first to point out some years ago, when lead-antimony grids came into fashion, giving substantial reasons for our assertions, and, we believe, the practice of using the latter has been abandoned by those who formerly advocated it. If it is desired to use separators between the plates, a very simple and cheap way to make them is to use perforated porous paper which has been saturated in melted paraffin wax, this, says the author, stands well in dilute acid, and he had some in use for several years. Referring to his method of preparing a solid electrolyte of plaster of Paris 1, sawdust  $2\frac{1}{2}$ , and dilute sulphuric acid until set into a compact porous mass, Mr. Barber Starkey relates that the cells filled in this manner and used on the Barking Road trams have apparently been a failure, although he had some success with this process in his own set of batteries. The defect of this arrangement would appear to be that it must hinder the free circulation of the liquid, and also add to the internal resistance of the cell, whilst, on the other hand, it prevents the plates from buckling, retains the active material firmly in its place, preserves the plates from injury and makes the cell very portable.

THERE are in the United States some 15,000 electric motors in use for almost every conceivable purpose, and the great majority of these are connected with central stations. One of the difficulties experienced by central

station managers was the charge that should be made to consumers for the use of electric energy. If all these motors were in constant use and giving off constant power, then it would be an easy matter to determine a fair rate for the current consumed, but few, if any, motors are doing constant work, some are at times much overloaded, others are never worked to their full capacity, and, as a rule, machinery in workshops must stand idle for considerable periods when work is being removed, prepared, or set in machine tools. Mr. H. L. Lufkin has made an accurate study of the conditions which obtain in various trades relatively to the average power consumed by machinery, and he has set forth the results in a series of diagrams illustrating the paper he read on this subject at the National Electric Light Convention. These diagrams illustrate the fluctuations in the current supplied to motors in actual practice, they give the maximum, minimum, and average readings, the current consumed in driving the shafting, and the peculiarity of the records of motors operating lifts. In some cases it is shown that over 60 per cent. of the average power developed by the motor is employed solely in overcoming the friction of shafting, where one large motor drives a number of machines. This would point to the advisability of using a number of smaller motors driving individual machines, and it is merely a question of relative efficiency between small and large motors. In a typical case of a 15 H.P. motor working lithographic presses the maximum rate consumed is 10 H.P. The user is given a 10 H.P. rate at \$60 per month, but the average power consumed is but 6.7 H.P., therefore he pays \$9 per H.P. per month instead of \$6 per H.P. for the power actually consumed. This difficulty, we think, could be easily overcome by attaching to each motor circuit a special meter. Meters of the ordinary kind for electric lighting are complicated and expensive, owing to the wide range they must have. Now a 70-ampere motor could never use less than 10 amperes, even if running an idle lathe or shafting, thus the extreme range would be about 1 to 7. Such meters could be made very cheaply and yet be perfectly accurate within such narrow limits; by this means both suppliers and consumers might be satisfied.

#### The West India Cables.

THE resuscitation of the scheme for a direct cable between Spain and Cuba, has given the Spanish technical press an opportunity of again inveighing against the concession granted in 1868, to the West India and Panama Telegraph Company, for a period of 40 years. This concession was given with the intention of making Cuba the centre of all the West India telegraph communications, the wording being to the effect that direct submarine telegraph lines should be laid between Cuba and Puerto Rico (two Spanish islands), and radiate from Cuba to Panama, to Mexico, and to South America. The telegraph company, however, instead of complying with the stipulations of the concession, laid a cable from Cuba to Jamaica, from Jamaica to Puerto Rico, from Jamaica to the isthmus of Panama, and connected up South America *via* the other West India islands, and in this manner declared the clauses of the concession fulfilled. The article from which we quote says:—"It is with shame that we must confess that this contempt of contract, this injury to national interests was consented to by the Spanish Administration." We are told that, not content with this infraction of the

most vital clauses of the concession, the telegraph company, jealous of its privilege, has taken every possible measure to prevent any other persons establishing a direct communication between Cuba and Puerto Rico. In view of the fact that the company has in no way fulfilled the stipulations of the contract, the concession must *ipso facto* become null and void, and it is the duty of the Spanish Government to further in every way the laying of a cable between Spain and Puerto Rico, and between Puerto Rico and Cuba.

## B.A. Ethics.

JUDGING from several letters which have recently appeared in *Nature*, it seems that the time is not far distant when some radical changes will be made in British Association procedure. The points touched upon in these communications, however, do not stand alone, for a comparatively new departure in the ethics of "learned" bodies has recently been made, which, if further developed, will scarcely tend to raise the standard of associations sanctioning such questionable policy. Two at least of the papers read before the British Association meeting had previously appeared *in extenso* in one of the scientific journals, and naturally it often occurs that the same individual submits papers on a certain subject before two or more societies. As a rule, the author has good taste enough to vary the text, and to introduce into each some special point of interest not common to both. But to write an article in a journal, get the credit, if nothing else, and subsequently present this very same article in the form of an original paper to the B.A., indicates motives which Mr. S. A. Varley would characterise as of questionable morality. Considering the publicity which is given to the deliberations of the British Association, there is not even the excuse of a desire for self-advertisement, and we can only put down such conduct either to a want of originality on the part of the authors, or to an utter indifference to the object which brought the association into existence. Had the authors been small fry there is but little doubt that their contributions would have been tabooed, but in the same way as there is said to be one law for the rich and another for the poor, so it seems that science panders to the great at the expense of its more humble devotees.

## The Latest Millionaire.

THERE is one means by which the B.A. meeting is rapidly bringing itself into world-wide notoriety, and which for several years past has been getting more and more ludicrous; we allude to the strange hallucinations under which Mr. W. H. Preece seems to labour and which give rise to those frequent utterances which at once make him the comic man of the party. In the daily press reports of Section G, last Tuesday, we noticed that Mr. Preece spoke of the extreme importance of preventing dangers to the public. During a lifetime associated with electricity, he believed he had experienced *a million shocks*. Small as were some currents, they possessed a certain amount of danger from shock or fright to the individual affected, and might perhaps cause stoppage of the action of the heart. Now, taking Mr. Preece's age as 56, a trifling calculation would apparently show that he has been receiving shocks, more or less severe, during all these long years at the rate of 50 per day, and yet he survives. But seeing that he did not enter the electrical profession until he was 18 years of age, and making

due allowance for Sundays and B.A. meetings, he has undergone muscular contractions during business hours at the rate of say, one in every five minutes, knocking out the decimals. The genial electrician of the Postal Telegraph made some further remarks upon skin resistance, and it is to be hoped that next year he will be able to place before the meeting a precise definition of both a thin and thick-skinned individual. We fear, however, that if he does not curb his too lively imagination, he will sooner or later receive a shock, not necessarily electric, which will seriously discount his remarkable gifts as a lecturer on science, even if it falls short of stopping the beating of his large heart.

## Newspaper Technics.

THAT the "Silly Season" has not yet come to an end, is evidenced by the correspondence in the *Daily Telegraph* on electric carriages, where the advisability of having private vehicles propelled by electricity is being as gravely discussed by people who know nothing whatever of the subject, as is that more complex matrimonial problem, originated by a recent breach of promise case, by those who apparently know still less. Let us first see electric tramlines commercially successful before troubling our heads with minor matters which can very well wait their turn until the time is ripe, if it ever comes, for dealing with them.

## A Graceful Compliment.

PROF. OLIVER LODGE must have experienced a proper degree of pride during the past week. Not only was a paper of his, previously published, read at the B.A. meeting, but an admirable portrait of the author of "Modern Views of Electricity," which probably excited the envy of all his less-favoured compeers, appeared as a supplement in an esteemed contemporary, the price of which, in honour of the event, or more probably in the true interests of science, was raised 50 per cent.

## Fire Risk Rules.

THE Phoenix Fire Office Rules have met with another rebuff at the hands of Mr. Wilson Hartnell, who, in his B.A. paper, recommends the adoption of those compiled by the Institution of Electrical Engineers. We hope soon to be able to devote special attention to this matter, the importance of which is shown by the completely opposite views taken on existing rules.

## The Georgetown Telephone Exchange.

WE have received an interesting account of the opening of the new telephone exchange in Georgetown, British Guiana, which is arranged for 200 subscribers. The whole of the work, which commenced last December, has been carried out by Creole labour, superintended by the Government Electrician, Mr. Samuel Vyle, who may perhaps be remembered by readers of the REVIEW of some years' standing. From what we can gather, Mr. Vyle has made himself quite indispensable in his sphere of operations, and appears to have become immensely popular with the Georgetown community.

## ELECTRIC LIGHT IN NEWSPAPER OFFICES.

THE advantages of the electric light are probably more fully to be found in the establishment of a daily newspaper than in most places, and the progress of the light in printing establishments throughout the country has become very marked. The latest installation of which we are aware is that at the offices of the *Manchester Examiner and Times*. This is an old-established paper, but it has of late changed hands, and the present proprietors have been making thorough changes with the view of enhancing their property, and one has been in installing the electric light in the place of gas; gas, however, is highly valued in this establishment, for it is used with one of Crossley's largest sized engines for driving the various printing machinery.

The installation in its present form consists of over 200 incandescent lamps of 16 C.P., but a larger number will be shortly added. The entire work has been carried out by the Manchester Edison-Swan Company, Limited, which has done the principal electrical work in this district for many years.

The lamps are placed throughout the building from the printing and paper rooms, where there are 32 lights, to the top, where over 100 lights are placed in the composing room. The offices and publishing department on the ground floor, the editor's and other rooms, are fitted up and appear to have been arranged with the view to extra light and comfort. The dynamo is of the company's Lancashire type, having a capacity of 300 lights, at an E.M.F. of 100 volts, with 900 revolutions per minute. It, however, is arranged, in this case, to run at 600 revolutions per minute, giving an output of 220 to 230 lamps at 100 volts. The engine is a special vertical electric light engine, by Marshall, of Gainsborough, with double fly-wheels, complete, for this special work. The speed is 150 revolutions per minute. The boiler is of the locomotive type, also by Marshall, arranged with the flue drawing downwards, and specially arranged to suit the confined situation it has to work in. The engine has been so fixed and arranged that in case of any accident or breakdown to the gas engine, it can be coupled up to drive the printing plant and other machinery. The wire and cable used throughout the installation is of Glover's double rubber insulation, and the capacity of the copper is calculated on the basis of about 750 ampères per square inch. The cut-outs, switches and holders, are all of the Manchester Edison Company's own patent type. The fittings are generally of a plain description, most of the shades being 9 in. flat opal. The work has been well carried out by the staff of the company, under the able supervision of their manager, Mr. M. P. James Fawcus, A.I.C.E., to whom the credit of planning out the entire arrangement is due. The installation has been started running within the last few days, and is working very successfully.

COMMUNICATIONS FROM AUSTRIA-  
HUNGARY.

[FROM A CORRESPONDENT.]

AS I already announced to you on a former occasion, the town of Teplitz purposes erecting electric works for lighting up this celebrated watering place. The town has resolved not to renew the contract for street lighting with the gas-works (which expires on August 1st, 1891), but to erect an electric central station at its own expense, and to carry it on as a municipal electric works. Concerning the right of the town to annul the agreement with the gas company, there prevail different views, and it may probably lead to litigation between the town and the company. Meanwhile, the municipality has already applied for proposals to different firms, e.g., Siemens, Ganz, Schuckert, Egger, Krenetzky, and Waldoek, jun., Wagner, without loss of

time. Several proposals have been already made to the town, both on the part of the gas company and of other contractors, applying for a concession for supplying an electric current. One undertaking even proposed to light up Teplitz, Aussig, and other towns of the district, from a common central station. The town, however, has declined all these offers, and has voted the sum of 300,000 florins for the erection of a municipal station.

Two localities, both within the town, had been proposed for the works. Subsequently it was judged better to erect the works outside the town, close to a coal-mine, so that the coal could be at once utilised on the spot without the cost of carriage. The coal-mine is about 600 metres distant from the town and about two kilometres from the most remote buildings to be lighted up. As the gas agreement expires on August 1st, and it cannot be expected that, in the case of its non-renewal, the gas company will further undertake the public lighting, the town must be prepared to have the electric works ready for action by that date.

A very interesting process between the city of Vienna and the Vienna Imperial Continental Gas Company has been just decided. The dispute did not refer to the carrying out of any definite claim, but formed a so-called "prejudicial accusation." The city wished to have a clear decision as to its future position with regard to the gas company, i.e., whether the company, after the expiry of its agreement, was entitled to leave the gas mains in the soil of the city—in other words, if the city, after such expiry, would be authorised to insist upon the removal of the gas mains. The Supreme Court decided that the Vienna Imperial Continental Gas Company, after the expiry of its agreement with the city, is bound to remove the mains and pipes from the ground. This decision holds good, of course, for undertakings for electric lighting with underground cables, and is, of course, very important. All such undertakings, in default of an express stipulation to the contrary, in virtue of the above decision, will be bound to remove their nets on the expiry of their agreements.

The Buda-Pest Tram-line Company (Siemens and Halske) has applied for a concession to lay down an electric tram-line on the right bank of the Danube, which subsequently, after completion of the fourth Danube bridge (recently projected), is to be joined to the net of electric tram-lines on the left bank. The new line is to terminate in a mountain line, and lead up to the celebrated Blocksberg, from which there is a splendid view of the city and its vicinity, and which, in the last few years, has become a very favourite resort of the public of Buda-Pest.

The Imperial Court management has resolved to provide all parts of the royal Hungarian castle, situated very picturesquely on the citadel, with electric lamps. If an electric installation is erected in Buda-Pest at an early date, these lamps are to be attached to the general net. If the execution of this project is too tedious, a special lighting station is to be erected for the castle, though outside its walls.

## THE DANGERS OF ELECTRICITY.\*

By Prof. HENRY MORTON.

WHEN the development of electric currents, on a large scale and at a small cost, first became possible by reason of the discoveries of Faraday, Wilde, Gramme, Siemens and others, the question of the dangers to life and property attending their use was brought prominently before the public, just as the dangers attending the use of steam, of rapid locomotion on railroads, and of dynamite were brought to the attention of the world when these powerful agencies first left the experimental

\* A paper read before the American National Electric Light Association, August 20th, 1890.

laboratory of the chemist or engineer to take their part in the ordinary labour and business of life.

In each instance alike there was a class of people who took the narrow and partial view, that if an agency was dangerous it should be excluded altogether from public use, or, what amounted to the same thing, be surrounded with such exclusions and limitations as would rob it of nearly all its capacity for usefulness, and restrict all possibility of advance and development in its application.

Thus laws were actually passed in England on the first introduction of steam, limiting the pressure in boilers to 30 lbs. on the square inch.

The first railroad charter contained a clause limiting the speed of trains to 12 miles an hour, and when a speed of 30 miles was suggested, it was ridiculed in a prominent journal of the day as an idea simply insane, and it was said that people would just as soon be persuaded to allow themselves to be fired out of a cannon as to be hurled along at such fearful velocities, which would, without doubt, have the most disastrous effects upon the circulation of the blood and other vital actions.

Some of us can also recollect the excitement produced and echoed in the press on the introduction of dynamite, and the stringent laws regarding its transportation, which in many cases only increased the danger to the public by occasioning its surreptitious conveyance in passenger and ordinary baggage cars.

We shall have to be very young indeed not to remember the great popular excitement brought about by the daily press when electric lighting first appeared in the streets of New York, and when flashes of flame were described as proceeding from a horse that had run against an electric wire.

In all the older instances matters have settled themselves in accordance with the laws of human progress and the diffusion of intelligence, and we now have boilers running at pressures of 140 lbs. and upwards, trains going more than a mile a minute, and gunpowder largely superseded by dynamite.

What is more, the accidents and injuries actually produced by these several agencies have been vastly less than those caused by the things which they replaced.

A much smaller number of people are killed or injured by high pressure boilers than by low pressure ones. How rarely do we hear of the explosion of locomotive boilers, which usually carry 140 pounds pressure.

The accidents to express trains are as nothing compared to those occurring with freight trains, and the loss of life and injury to passengers by rail is insignificant in its percentage to the number carried, when compared to similar loss and injury incurred in the days of stage coaches.

The same relation has been found between dynamite and gunpowder, the former having largely reduced the proportion of accidents and injuries as compared with the work done.

Two lessons are very plainly taught by the facts of history above alluded to.

First: The world is not going to be frightened away from a new and valuable source of power by the circumstance inseparable from the very nature of all powerful agencies, that it is dangerous if not adequately controlled; but, on the contrary, will develop the new power to an ever-increasing and, therefore, more (possibly) dangerous intensity.

Second: Intelligently managed and controlled, the most powerful and, therefore, in a sense, dangerous agencies, become the most efficient protectors and servants of man, and not only aid him in his mission of subduing and utilising nature, but actually protect him in his work.

Without these "dangerous" agencies man would be reduced to the lowest condition of savagery, where he would be at all times helplessly at the mercy of the "elements," or the blind forces of nature.

With them he not only defies and subdues the beasts which would otherwise be his superiors, but even conquers and renders tributary to his comfort and advance-

ment those vast forces which control the entire matter of the universe.

Applying these lessons taught by the past history of the world in parallel cases to the problem of the distribution and use of electricity, we see, in the first place that the way to deal with its dangers ought not to be the timid, obsolete way of prohibition, or of unintelligent restriction, such as that which proposed the exclusion of locomotives from railroads, or the limiting of their speed to 12 miles an hour, but the sensible way of providing adequate safeguards to the new power, and with these allowing it to follow its natural line of development and growth into higher and higher ranges of intensity and consequent efficiency.

It is too well known to all to need statement, that the methods thus pointed out by history and taught by experience have not been by any means universally advocated or followed, and that while many have loudly demanded the exclusion of powerful electric currents, the limitation of their intensity to what they suppose to be necessarily harmless ranges, the users of such electric currents have in too many cases neglected the most obvious precautions.

It is only fair to say, in explanation of this latter statement, that this neglect has in many cases been brought about by obstructions thrown in the way of good work by those who were exciting themselves for the total abolition of dangerous currents, and who, like certain "total abstinence" advocates, objected to every mitigation of the evil they attacked, because any such improvement weakened their case against it.

As regards dangers to property from fires, the matter fortunately fell at an early period into the hands of the Board of Fire Underwriters, who, in a judicious and business-like way, investigated the subject and formulated such rules as have proved eminently satisfactory, and have proved that under proper regulations as to good work and means of protection, electricity is by far the safest means known to us for the distributing and development of light, so far as "fire risks" are concerned.

In view of the satisfactory results thus obtained, I regard it as a fortunate circumstance that the other part of the problem, namely, that relating to dangers to human life, has been recently taken in hand by a similar organisation known as the "Employer's Liability Assurance Corporation."

This association, after collecting a mass of material from a great variety of sources, has some time since formulated a series of rules for the protection of those employed in erecting and operating electric apparatus involving the use of powerful, and, therefore, dangerous currents. These rules have been examined and approved by several of the managers of prominent electric companies, and, so far, it would appear as if no accidents have resulted from the use of electric currents where these rules have been followed, and that most, if not all, the accidents which have occurred would have been prevented had these rules been followed and obeyed.

Having had something to do with the framing of these rules, it is my chief object in presenting the present paper to secure their criticism by those bestable to perceive their imperfections, and such suggestions as may lead to their beneficial modification or extension.

I therefore quote them as follows:—

First. Do not touch or handle any electric wire or apparatus of any sort while standing on the ground, or while in contact with any iron work, gas or water pipe, or stone or brick work, unless your hands are covered with rubber gloves, and you are provided with such properly insulated tools as have been declared to be safe and in good order by the electrician or other competent officer of this company.

If it is at any time necessary to stand on the ground, or on any surface not insulated from the ground, while handling electric wires and apparatus, rubber boots or an insulated stool should be used.

In moving wires, hanging on, or lying over, electric light wires, lamps or fixtures, use a dry hand line,

Second. Never handle any electric wire or apparatus with both hands at once when this can be avoided, and, if it is necessary to do so, be sure that no current is present, or that one or both hands are protected by rubber gloves or other efficient insulation.

Third. When handling line wires, treat each and every wire as if it carried a dangerous current, and under no circumstances allow yourself to make contact between two or more wires at the same time.

Fourth. Never open a circuit which has been in use without giving notice to the superintendent, or whoever is in charge, of your intention to do so, and at the same time request that the same line be opened at the main station, and kept open until you have given notice that your work on that line is complete.

Fifth. In the dynamo room never go near the belts or dynamos, nor touch any apparatus unless you are fully informed and instructed how to do so.

Tools used by linemen should be provided with insulating handles of hard rubber or other equally good insulator. It is the duty of each lineman to look after his own tools and see that they are in good order, especially as to their insulation.

Sixth. Lamp trimmers and others engaged in the care of lamps must see that the switch putting the lamp in circuit is turned off before they handle the lamp in any way.

Seventh. In construction work, a space of at least 20 inches must be left between the holes for pins on the cross arms, so that a lineman may get to the top of the pole and work without danger.

The same insurance association has collected the authentic records of a number of so-called "electric accidents" or accidents happening to the *employés* of electric companies. I have now before me the abstracts of 91 such cases.

The first thing that presents itself in looking over this set of abstracts is that very few of the accidents are in any way attributed to electricity directly, but would have occurred had the establishment in question been any kind of a factory where power was being used, or any place where heavy objects were being moved. A few examples will illustrate this, thus:

"No. 1. Whilst steadying with a pike-pole a large electric light pole which was being placed in position, a passing 'low-gear' belonging to the Standard Oil Company ran over ankle."

"No. 2. While assisting in hoisting a stick of lumber from the street to the second floor of electric station, was injured in right foot by having the stick fall upon it."

"No. 9. Was going to dynamo, stepped on iron plate temporarily covering a belt hole in floor. The plate tipped and he fell partly through the opening, injuring himself internally."

"No. 17. Was oiling rocker shaft of engine near fly-wheel; leaned back too far and was struck on head by spider of fly-wheel."

The above are fair samples of the rest, and, in fact, out of the 91 cases but 15 (or about 16½ per cent.) have any direct relation to electricity.

As I have already mentioned, of the 15 cases in which the injury was in any way caused by electricity there are none in which the action would not have been avoided if the above quoted rules had been observed. Thus, beginning with first in order as arranged in the abstracts, all before it having no direct connection with electricity, we have:

"No. 11. While removing the wire from a Brush dial or regulator which had become short-circuited, was slightly burned on two fingers of right hand."

In this case the beneficial effect of rule No. 2 was manifestly expressed, and had the spirit of rule 7 been complied with even the slight injury experienced would have been avoided.

The next in order is:

"No. 20. Was putting carbon in electric lamp which was out of order and failed to burn. Received charge of electricity, which caused him to fall down from step-ladder on to steam radiator. Two ribs broken."

This would clearly have been avoided by an observance of rule 7.

Time will not permit me to quote all the 15 cases, and I will, therefore, only repeat that they would, all of them, have been avoided by a strict observance in form and spirit of the above quoted seven rules or directions.

Of course I do not mean to imply by this that these rules are perfect or complete, but only that they seem to be in the right direction, and to furnish a starting point from which further developments may proceed.

No one having even an elementary knowledge of electricity as it existed 10 years ago, needed or needs to be convinced of its power to do harm where all safeguards are removed, and the occasional declarations of its harmless character which have been uttered can only be accounted for by reference to that combative disposition which impels some minds always to take a view in opposition to any which may be expressed, and gives birth now and then to a book or pamphlet disproving the law of gravitation or the solar origin of light and heat. To say this is, however, far from agreeing with the other extremists who would banish electricity from our daily walks and occupations, or place it under restrictions which *might* render it harmless, but which *certainly would* render it relatively useless for the countless purposes in which its efficiency demands its full development.

The true opinion is that which is supported by past experience, and which advocates the fullest developments of power to which this agency can attain, combined with the use of all the means of protection by which human intelligence can protect itself while using to the utmost this potent and, therefore, dangerous weapon in our victorious contest with the inimically destructive forces of nature.

## UNDERGROUND CONDUCTORS IN MADRID.

THE *Ciencia Electrica* of Madrid, is publishing a series of articles, written by Senor J. Casas Barbosa, formerly the manager of the Sociedad Matritense de Electricidad, under the title of "Electricity in Spain." The electric lighting of Madrid naturally claims precedence, and the articles in question deal, for the present, with the operations, in that city, of the company above-mentioned. Especial mention is made of the installations in the gardens of Buen Retiro and in the park of Buenavista, including, in the latter, the illumination of the Ministry of War.

In reviewing the results of the distribution of current by means of overhead wires, the conclusion is arrived at that this method is altogether unsatisfactory, experience showing that it is untrustworthy, precarious, and only suitable for purely temporary necessities.

In view of the uncertain nature of overhead lines, the Sociedad Matritense turned its attention to the question of canalisation and underground conductors.

Many difficulties were encountered in realising the proposed change, among them being the exclusive authority over the public roads assumed by the gas company, and which had been tacitly assented to by the authorities and the public, though unsupported legally.

In the year 1883, Senores Dalman and Losada obtained the right of canalisation over a considerable area, but the experiment was actually extended to only the very limited distance of about 2 kilometres. The system consisted of a conduit of Portland cement, containing two parallel semi-circular troughs. The conduit was covered in with blocks of cement. Wires covered with tarred tape were laid down, but on account of the damage caused to this covering by haulage and the frequent presence of water in the conduits, the system failed completely.

By degrees the tape-covered wires were replaced by others covered with impregnated yarns and enveloped with lead, but the porosity of the metal caused frequent disasters, although, in some cases, the experiment

was tried of placing a double covering of lead over the wires.

In 1886 the condition of the cables had become so bad that it became necessary to attempt some further remedy. Pieces of wood impregnated with tar were placed at short intervals along the conduit. The wood was shaped to fit the semi-circular troughs, and on the upper edge slots were cut to receive the cables, which were thus suspended clear of the sides and bottom of the troughs. After six months' service it was found that excessive leakage prevailed over the system, and on examination it was discovered that an electrolytic action had been set up at every point where the cable was supported by the wood. These pieces of wood were consequently replaced by well-lacquered porcelain supports, which have given very much better results.

The author considers that a lead covering to the cables frequently constitutes a serious danger, and he goes on to say that, in his opinion, a bare copper bar, suspended by means of insulators from the arch of a conduit, presents the best method of insulating an underground conductor. At the same time, the case is quoted of the Barcelona installation, where bare copper bars were placed underground in the manner above indicated. The system signally failed, owing to the presence of water in the conduits.

the travelling over a slack rope would prove more interesting and attractive to the general public than a rigid rail.

Telpherage has taken some years to bring to its present perfection, but during that time the difficulties, which have naturally arisen in an undertaking of such a character, have been successfully met, and the particulars now made public seem to be convincing of the simplicity and reliability of this, the most modern method of transport.

The system comprises arrangements for the transport of a wide range of material, from minerals and heavy freight to light packages, the lines being constructed for the particular purposes for which they are required. These lines partake of the same general character, the practical effect being an overhead line, with carriers specially suited for the employment of electricity in the transmission of the power required.

The Edinburgh line consists of over a quarter mile of track, the flexible portion of it being constructed in spans of 50 feet, and the rigid ends in spans of 15 feet. The stand ropes on which the locomotive and carriages travel are of crucible steel, and  $1\frac{1}{2}$  inches in diameter. These are tightened, so that with a full load on the line there is a sag of about 2 feet  $4\frac{1}{2}$  inches on the spans covered by the train.

The arms supporting the stand rope are arranged so that they move in either direction, allowing the sag in



We would also point out that in an earlier portion of the article the author refers to the installations at the club "Union Mercantil," and at the theatre "Romea," where the conductors, underground cables covered with India-rubber, have given exceptional satisfaction, the lengths of circuits being, altogether, about 16 kilometres.

In view of the extensive experience which Senor Casas Barbosa apparently has had with different systems under various conditions, his opinion as to the efficiency of bare copper rods deserves some measure of attention on the part of those engaged in laying underground electric light wires. We may add that the climate of Madrid is, generally speaking, very dry, with extremes of heat and cold.

### CHEAP TRANSPORT.

THE Electrical Engineering Corporation of London and West Drayton, since securing the sole rights for the Telpher system of cheap transport, have been vigorously developing the system, and determined to put up a Telpher line on a practical scale at the Edinburgh Exhibition to show the most recent improvements, and to so arrange the line as to carry passengers, and demonstrate the advantages of the system for the transport of goods. As a rule, they recommend rigid lines for the carriage of passengers, but it was thought that

the rope to follow the train as it moves along, thus obviating any undue strain upon the posts themselves. The stand rope at its junction with the rigid rail passes from a special descent junction saddle, so arranged that the train rises from the rope on to the rigid rail without any jerk or other unsatisfactory movement. From the junction saddle it passes direct to a structure termed the abutment post; this is fastened to the substantial anchorages in the ground by flexible steel ropes 5 inches in circumference. The strain upon the ends of the stand rope with a fully-loaded train is about 5 tons, and the strain upon the anchorages about 8 tons.

The current is conducted along a conductor, which is not attached to the insulators on which it rests at any point, but merely rests upon them. From the locomotive a rigid arm projects underneath the conductor, but above the insulators, and slides along under the conductor, lifting it off the insulators as the arm passes them, allowing it to rest on them again after it has passed. This method of collection, which is recommended in the "Waller-Manville" system of electrical traction, is proving admirably satisfactory.

The train, as will be seen from the illustration, is a very practicable one; the cars, which with the plant and the rest of the equipment were made at the works of the Electrical Engineering Corporation at West Drayton, are built much in the fashion of railway carriages, each car having two compartments and holding four persons, and each compartment being entered from a door with a railway latch. The space

in the cars between the passengers is the same as is allotted on the District Railway in their second class coaches. The whole of the car is suspended by iron hangers from two bogie trucks, the bodies of which latter consist of iron castings resting on the axles of the wheels at each end, and the hanger does not depend directly from the body of the bogie truck, but rests upon two vertical springs contained in boxes on each side of the body.

The locomotive consists of what is termed by the corporation a swinging tub, and the motor drives a small countershaft, to one end of which is attached an electrical governor to maintain a set speed; the other end of the countershaft has upon it a chain wheel which drives directly upon a larger chain wheel contained on the upper frame. The motor is suspended from the upper frame by a hanger, so arranged as to allow the whole to swing, the swinging movement thus allowed not interfering with the motion of the chain, as it is a movement radially to the centre of the large chain wheel on the upper frame. The upper frame contains, in addition to the large chain wheel, two driving wheels with malleable cast iron tyres to grip the rope, each attached to a chain wheel driven from the shaft supporting a large central train wheel.

The working of the line has, up to the present time, given every satisfaction, and has elicited considerable attention.

SPAIN AND MOROCCO CABLES.

THE *Ciencia Electrica* of Madrid, publishes an article upon the long felt want of some speedy and trustworthy means of communication between Spain and her possessions on the northern coast of Africa, and cites as an instance of this necessity, the recent troubles at Melilla, a Spanish fortress and convict settlement on the Riff coast of Morocco.

It is pointed out that as a first step towards protecting Spanish interests in Morocco, the example should be followed of the English, who have laid a cable between Gibraltar and Tangiers. This step is all the more necessary, in view of the attacks so frequently made on the Spanish outposts, by uncontrolled tribes, there being no telegraphic communication between the various military stations, or with the Peninsula. Considering the urgency of the case, the cost of the proposed cables, though assuredly a considerable item, ought not to be looked upon as an insuperable difficulty.

The Royal Decree of August 14th, inviting tenders, contains full details of the scheme, and particularises the proposed lengths of cables, as follow :

	Shore end.	Heavy intermediate.	Inter-mediate.	Light inter-mediate.	Deep sea.	Totals.
Tarifa-Tangiers ...	6.0	10.0	6.0	8.80	...	= 30.80
Tarifa-Ceuta .....	6.0	12.0	4.0	...	...	= 22.00
Almeria-Alboran...	6.0	20.0	6.0	15.0	36.60	= 83.60
Alboran-Melilla....	6.0	10.0	6.0	10.0	18.80	= 52.80
Melilla-Chafarinas	6.0	6.0	9.0	8.15	...	= 29.15
Melilla-Alhucemas	7.0	20.0	6.0	15.0	36.60	= 84.60
Alhucemas - Peñón de Vélez .....	6.0	10.0	6.0	8.80	...	= 30.80
Totals.—N.M.=	43.0	90.0	43.0	65.75	92.0	= 333.75

With the exception of Tangiers, the proposed cables connect up no points of commercial importance, their *raison d'être* being purely political, and the attention now paid to the Morocco question is significant of a more active policy on the part of Spain. Fear of the results of French enterprise and influence, always a thorn in the side where Africa is concerned, has no doubt assisted towards the inauguration of a more determined course with regard to Morocco.

NOTES.

**Burton Backward.**—At a recent meeting of the Burton-on-Trent Town Council, the Gas Committee reported the receipt of the Parliamentary Electric Lighting Order, but added that they had as yet taken no further steps in the matter.

**The Electric Light at Huddersfield.**—At the last monthly meeting of the Huddersfield Town Council, it was reported that the sub-committee had considered the advisability of taking steps for establishing an electric lighting station, under the provisional order which the corporation had obtained, and had appointed the mayor, the chairman, the vice-chairman of the sub-committee, and Mr. Calvert to inspect the electric light systems in operation in other towns and to report thereon.

**Palace Lighting.**—The Emperor of Austria has decided that the electric light shall be introduced into his palace in Vienna, the Hofburg, where till now wax lights have generally been employed for the purpose of illumination. About 8,000 incandescent lamps will be required to light the building throughout.

**Execution by Electricity.**—A telegram from New York dated the 11th inst., reads :—"The writ of habeas corpus in the case of the Japanese Shubuya Jugiro, who was convicted of murder, and sentenced to be executed by electricity, has been refused. The counsel who resisted Kemmler's execution presented a writ declaring that the condemned man would be carbonised and tortured to death. The judge, in dismissing the writ, alluded to the sentence carried out on Kemmler which, he said, the United States Supreme Court had decided was legal."

**Telephonic Communication between London and Paris.**—The Hythe Town Council, on Wednesday, granted permission to the Postmaster-General to erect posts and wires in the borough.

**The Electric Light at Lewes.**—At a recent meeting of the local town council, the question of electric lighting was discussed. Mr. Farncombe, comparing the advantages of gas and electric lighting, said the Gölcher (New) Electric Light and Power Company, as notified in last week's REVIEW, proposed to give 240 lamps of 16 candle-power, and to light seven and a half miles of streets, at a total annual cost of about £600, as against £800 now paid for the 200 odd gas lamps. He believed the present gas mains only extended over about five miles and a half. If the council erected the plant themselves and capitalised the cost in the usual way, the total yearly expense of the electric light would be about the same as now paid for gas, while in the course of time the whole of the plant would belong to them and there would only remain the cost of maintenance. Men who had studied the subject, declared that where electricity had been introduced the gas companies had done better business than before. The contrast between electricity and gas was so striking that the gas consumers was compelled to go in for improved burners and more gas lights, consequently they burnt more gas. Several of the largest ratepayers in Lewes strongly urged that the electric light should be adopted. He saw a good many people, and he had not heard a single word against it. The corporation owned three sites that were available for the machinery to produce the electric light, and he was informed that their situation was admirably adapted for the suggested change. Further consideration of the matter was adjourned.

A strong opinion exists in favour of the adoption of the electric light, and it is understood that a public meeting will be convened by the mayor shortly, to go into the subject. Several of the borough officials, including the Medical Officer of Health, are in favour of improved lighting, while one large ratepayer has already expressed his desire to have the electric light laid on to his house.

**The Electric Light at Bristol.**—The Sub-Electric Lighting Committee appointed to visit certain parts of the country in search of information, has now reported to the General Committee. The last town visited was Bradford, in Yorkshire, where the corporation owns both the gas and the electric light, but only uses the latter for private lighting. The sub-committee recommends that the corporation shall take the electric lighting into its own hands, and that from 60 to 70 1,000 candle-power arc lamps should be erected in the main streets of the area comprised between Temple Meads and the Victoria Rooms, and College Green and Old Market Street.

**The Electric Light at Winchester.**—A short time since the corporation of Winchester advertised for tenders to light that city by electricity. Strangely enough, no reply has yet been received to the invitation.

**The Electric Light at Derby.**—At a recent meeting of the Town Council the Mayor proposed that a permanent committee, to be called the Electric Lighting Committee, be appointed until November next, and also annually on the 9th of November each year, with power to consider the provisions of the Electric Lighting Order, and to make such arrangements as the council might deem expedient. He further moved that it be a special order that the Electric Lighting Committee should consist of 11 members of the council, and the Mayor for the time being *ex officio*. The proposals were agreed to.

**The Electric Light at Nelson.**—The Nelson Gas Committee has instructed the gas manager to take the preliminary steps for permanently illuminating the principal streets of the town by electricity.

**The Electric Light at Dundee.**—At the last monthly meeting of the Dundee Gas Commission a statement was submitted showing that during the past four months the amount of gas delivered in Dundee was 65,976,700 cubic feet, being an increase of 9,656,400 cubic feet on the consumption last year. Mr. Henry Robertson stated that with a steadily increasing consumption of gas the board were apt to remain quiescent in regard to electric lighting; but he reminded them that there were at present a score of public works supplied with the electric light. Those who were supplied with the electric light were delighted with it. A letter from the Electric Installation and Maintenance Company, Limited, tendering its services for the construction and maintenance of electric works in Dundee was allowed to lie on the table.

**The Electric Light at Fareham.**—An experimental installation of the electric light for the illumination of the Fareham streets was made on last Friday night, over a portion of the system, by the Fareham Electric Light Company, the experiment being regarded as very satisfactory. The system adopted is the Thomson-Houston, and the currents are supplied from two dynamos located close to the steam flour mills. The Local Board has engaged to pay £500 per annum for the lighting.

**Private Electric Lighting.**—The residence of Mr. Matthew Stevenson, of Harrogate, has been recently fitted with a complete installation of incandescent lighting. The wiring and fitting were entrusted to Mr. E. C. Wallis, of Bond Place, Leeds. As this is the first private installation in Harrogate, no effort has been spared to make it successful.

**Ship Lighting.**—The R.M.S. *Dunnottar Castle*, the largest vessel in Messrs. Donald Currie & Co.'s fleet, made her trial trip on the Clyde last week. All modern improvements, tending to the safety and comfort of passengers, have been adopted, including an excellent electric light installation by Messrs. Siemens Brothers.

**Electricity v. Gas.**—A lengthy controversy over this subject, in connection with Fareham lighting, is taking place in the *Portsmouth Times*.

**Nothing to Fear.**—At the annual general meeting of the Sunderland Gas Company, recently held in Newcastle, the chairman said that for some years past he had made references to the electric light, but now he had nothing to say, as there was nothing to be dreaded.

**Aberdeen Hammermen's Exhibition.**—A recent addition to the attractions of this exhibition is a powerful search light, erected by Messrs. Macwhirter, Ferguson and Co., electricians, Aberdeen. The light is a naval projector, manufactured by Messrs. Crompton & Co., Chelmsford, having a 24-inch parabolic mirror and arc lamp for concentrating the beam, and is equal to from between 20,000 and 30,000 candles.

**Business Extension.**—Messrs. Elliott Brothers, the well-known electrical, optical, &c., instrument makers, of St. Martin's Lane, having found it necessary, owing chiefly to the large increase in the volume of their business to greatly add to their premises, are making a large addition to their existing works. The building, which is quite a feature in the new street leading from Charing Cross to New Oxford Street, has a handsome façade of fine Dorset stone, and is characteristically named "Faraday" House. The back of the new building abuts on the back of the old premises which face St. Martin's Lane, the whole occupying a space of about 10,000 square feet. Although most of the space occupied by the new building will be employed as workshops, &c., by Messrs. Elliott, a portion fronting on the new street is to be occupied by "The Electrical Standardising, Testing, and Training Institution." The success of the firm, which has such a world-wide reputation, is a matter for congratulation, and is well deserved.

**Edinburgh International Exhibition.**—The East of Scotland Engineering Association held a special session at the Exhibition on August 5th and 6th. Amongst the papers read was one on the "Protection of Buildings from Lightning," by A. R. Bennett, Vice-President of the Association, in which the effects of several recent storms in Scotland on buildings and telegraph wires were described; and one descriptive of the telephonic exhibits, by C. G. Wright, Fellow. The remaining papers dealt with the mechanical exhibits, the one by Prof. Elliot, on the Locomotive Annexe, being specially noteworthy.

**The Telephone in Great Britain.**—The Central News says the expiration of the telephone patents in England will begin on the 9th of December next, and the monopoly will soon cease, and the *Sheffield Daily Telegraph* observes that, "so far, it has hardly been possible to purchase a telephone at any price, the only way to procure one being by paying a rental of £15 to £30 a year. We understand that Mr. A. Erskine Muirhead, of Glasgow, has been urging the telephone company to adopt the 'Ader' or 'Berthon' telephone, which at this moment enables people over 600 miles apart to speak with ease. Mr. Muirhead has demonstrated the practicability of telephonically connecting the towns of Great Britain by means of existing railway wires, and with the help of Van Rysselberghe's system. There is thus nothing wanting but comparatively inexpensive apparatus to enable, say, London to converse by telephone with Birmingham, or Bristol, or Aberdeen, at the same moment as telegraphic messages are being sent over the same wires. This practice has been in operation in Belgium and France since 1882. As is well known, people can telephone from Brussels to Marseilles, *viâ* Paris."

**Notice of Removal.**—Messrs. C. E. G. Gilbert and Co. have removed to No. 16, Hanway Street, Oxford Street, W.

**Electric Welding.**—*The Practical Engineer* concludes an article on Sir Frederick Bramwell's paper as follows:—"So far the applications have been to work not in competition with ordinary welding smith work, and we are of opinion that electric welders will not compete with ordinary work, as they are entirely inapplicable to the great mass of forge work, and the expense of use puts them outside of applications other than special and peculiar." We congratulate our contemporary on being so plain spoken.

**The "Peral."**—If certain of the Madrid journals are to be believed, it would seem that the submarine boat *Peral* has not turned out a failure after all. We are told that the reason for not building any more vessels after the pattern of the *Peral* is because one of the secret contrivances, appertaining to the submerging mechanism, has been made public by an English journal, while Spaniards were kept in ignorance of all details connected with the invention. The periodical we quote from goes on to say that, so long as six out of the seven especial inventions comprised in the mechanism of the *Peral* remain secret, there is nothing much to lament over, and the Government is adopting a proper measure of reserve in abstaining from further construction until the day when, Spain being at war, these powerful engines of destruction can be made use of against an enemy as novel weapons of offence.

**The Compound-Winding Case.**—The reason why the appeal to the House of Lords has been made may be seen by referring to the report of the Brush Electrical Engineering Company's first annual meeting. Those who have paid royalties for the use of compound-winding will doubtless feel flattered at the consideration which the company deigns to give them, more especially as nothing is recoverable should the appeal be dismissed. But surely, if the statement made by the chairman at the end of his last speech is correct, the manufacturers who have hitherto paid royalties can refuse to do so any longer, even if the company is successful in the House of Lords, on the ground that their dealings were with a previous corporation?

**Railway Telegraph Engineers.**—The Society of Railway Telegraph Engineers is to hold session in the Edinburgh Exhibition on the 16th and 17th of this month. The society is composed of the telegraph superintendents of the different railways. Two important exhibits, illustrating the telegraph, the signalling, and the block systems of two of the leading railway companies, will prove of special interest.

**The Electro-Magnet.**—The Journal of the Society of Arts for September 5th contains the first of the Cantor Lectures by Prof. Silvanus Thompson, D.Sc., B.A., M.I.E.E., delivered January 20th, 1890. The subject treated of is "The Electro-Magnet," and the inventions of Sturgeon, Henry, Roberts, and Joule are described.

**Proposed Electric Tram at Hastings.**—At the last monthly meeting of the Town Council a communication was received from Mr. J. Lees, enquiring whether the Council would entertain a project for a single line electric tramway south of the present parade rails from a point nearly opposite the Palace Hotel and the South Colonnade. The matter was referred to the Council in committee.

**A Well-Known Fact.**—A facetious friend, who noticed that in some of the B.A. papers attributed to certain authors, the mathematical portions were eschewed during the reading, suggests that the tendency on these occasions is merely to general lies. There is nothing new in this.

**Electric Traction in Italy.**—In the course of a few days the electric tram service between Florence and Fiesole will be open to the public. The preliminary trials have been highly satisfactory.

**Electricity in Artillery Practice.**—*Engineering* last week reproduced a very complete description, from the *Revue d'Artillerie*, of Paris, of the Canet system of quick-firing guns, which are equipped with electrical devices for training both in elevation and direction. If we are not much mistaken, the same ideas were carried out some years ago by Mr. Maxim, Mr. Crompton, and others, and although perhaps never put into practical operation, they were experimentally successful.

**Cable Ships.**—The ss. *Westmeath* arrived at her moorings off Messrs. Henley's Telegraph Works at Woolwich on the 8th inst. She is about to load cable for the extension of the Société Française des Télégraphes Sousmarins system in the West Indies. We believe the first section to be laid on this expedition will connect the French Island of Martinique with the town of Paramaribo, in Dutch Guiana. She is expected to leave the river early in October.

The ss. *Silvertown* came to her moorings off the Silvertown Company's Works on the 10th inst. She will take in cable for the West Coast of South America, the Central and South American Telegraph Company having resolved to continue their system southwards, from Lima, the capital of Peru, to Valparaiso, the chief port of Chili, touching *en route* at Iquique, the nitrate port, only. This extension of the Central and South American Company's cables would appear to threaten a serious rivalry to the existing lines along the coast, owned by the West Coast of America Telegraph Company. The *Silvertown* is expected to leave the river about the middle of October.

**The Aluminium Company.**—At the annual ordinary general meeting, held on Tuesday, at Cannon Street Hotel, Mr. Gerald Balfour, M.P., the chairman, said, amongst other things, that when the company was formed, it was expected the discoveries of Mr. Webster and of Mr. Castner, two of the vendors, now upon the board, would enable the price to be reduced from 60s. to 20s. But all their calculations were overthrown by the invention of an electric process for the production of the metal, which brought the cost down to 6s. or 8s. But he was glad to say that, though the metal could not be produced at a lower cost by their present process, yet Mr. Castner and Mr. Webster had discovered new processes of making aluminium and sodium, which, it was hoped, would once more enable them to compete with the electric process as far as the production of aluminium was concerned; while they would, it was hoped, also have a large sale for sodium.

**New Zealand and the Cable Rates.**—The New Zealand Government declines to bear a share of the subsidies and guarantees required by the cable companies in connection with the proposed reduction of the telegraph rates between Australasia and Great Britain, owing to the refusal of the Imperial Government to bear any portion of the responsibility.

**Fatal Gas Explosion.**—Yesterday forenoon a serious gas explosion, attributed to a leakage from a gas engine, occurred at the electro-plate works of Mr. C. H. Worsnop, in Cheapside, Halifax. The explosion almost brought down the building and set it on fire. A young man, named John E. Worsnop, was buried in the *débris* and has not been found, and a young woman, named Hartley, a burnisher, was killed, whilst a labourer was so seriously hurt that he lies in the infirmary in a precarious state.

#### NEW COMPANIES REGISTERED.

**Railway Construction and Maintenance Company of Mexico, Limited.**—Capital, £100,000, in £10 shares. Objects: To construct, maintain, and work railways, tramways, gas and electric lighting works, telegraphs, telephones, or other works. Signatories (with 1 share

each): C. Chabot, Romford, Essex; W. J. Longhurst, 20, Abchurch Lane; R. J. Garwood, 354, York Road, Wandsworth; G. Mannafor, Hendon; H. M. Winears, 15, Crossfield Road, South Hampstead; A. J. Kent, 8, Cross Road, South Wimbledon. The signatories are to appoint the first directors. Qualification: £500 in shares or stock; the company in general meeting will determine remuneration. Registered, 3rd inst., by Messrs. Bircham & Co., 50, Old Broad Street.

**John Smith and Sons, Limited.**—Capital £250,000, in £100 shares. Objects: To acquire the business of wool combers and worsted spinners, carried on by John Smith and Sons, at Field Head Mills, Bradford; to generate electricity, and apply the same for purposes of lighting, or as a motive power; and to supply electric light to any persons willing to purchase, rent, or use the same. Signatories: J. W. Smith, Mrs. Sarah Smith, B. Smith, John Smith, \*J. White, F. White, 1 share each; \*Isaac Smith, 10 shares; all of Bradford. The signatories denoted by an asterisk are the first directors. The company in general meeting will determine remuneration. Registered 4th inst. by Mr. C. Doubble, 14, Serjeant's Inn, Fleet Street.

**London and Western Syndicate, Limited.**—Capital, £10,000, in £1 shares. Objects: To search, prospect and explore countries, districts and places in America, Canada and elsewhere for the discovery of openings for the profitable employment of capital, and to execute and carry out public works of all kinds, including gas, electric light, telephonic, telegraphic and automatic power and other works. Signatories (with 1 share each): N. P. M. Tronson, 8, Drapers' Gardens; B. F. Weeks, 16, St. Helen's Place; R. Leapmann, 124, St. Vincent Street, Glasgow; F. H. Homan, 8, Drapers' Gardens; P. J. Economides, 79, St. Helen's Gardens, W.; G. Allan, M.I.C.E., 10, Austin Friars; W. Curtis Thomson, 10, Throgmorton Avenue. Registered, 8th inst., without special articles, by Robinson & Stannard, 17, Eastcheap.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**General Electric Company, Limited.**—The annual return of this company, made up to the 2nd inst., was filed on the 5th inst. The nominal capital is £60,000, divided into 7,000 first preference shares, 1,000 second preference shares, and 4,000 ordinary shares of £5 each. 10,505 shares are taken up, and of these 4,000 ordinary and 1,000 second preference are considered as fully paid. Upon 5,505 first preference the full amount has been paid, the calls paid amounting to £26,275, and unpaid to £1,250.

**Pilsen, Joel and General Electric Light Company, Limited.**—A meeting of this company was held on the 5th inst., when an account was given as to the manner in which the winding-up of the company has been conducted and its property disposed of. The notification of the meeting was filed on the same day.

**Tilbury Portland Cement Company, Limited** (manufacturers of concrete and metal telegraph poles, signals, tubes, &c.).—The statutory return of this company, made up to the 12th ult., was filed on the 18th ult. The nominal capital is £25,000, in £5 shares. 2,992 shares have been taken up, and £2 per share has been called. Upon 200 shares the full amount is considered as paid. The calls paid amount to £5,422 10s., and unpaid to £161 10s.

**District Messenger Service and News Company, Limited.**—An agreement of the 6th June (filed 1st inst.), with C. T. Russell, provides for the purchase of the "improvements in electrical signalling apparatus for police service and the like" (provisional protection, No. 6126, granted to R. D. Radcliffe, 22nd April, 1890). Also "Improvements in and relating to printing telegraphs, and to the distribution of news transmitted thereby"

(provisional protection, No. 8031, granted to R. D. Radcliffe on 22nd May, 1890). The purchase consideration is £39,750, payable £15,000 in cash and the balance in fully paid shares. The company will also take over the office of the vendor at 4, Northumberland Avenue, with all instruments, furniture and effects therein at such price as may be determined by a valuer to be appointed by the directors.

An agreement of the 29th ult. (registered 1st inst.) stipulates that the vendor shall not be entitled to require the company to make any payment in respect of the cash portion of the purchase consideration under the principal agreement, except as provided by the following articles. All money received by the company for subscriptions in respect of the first 4,000 shares of the company subscribed for in cash shall be retained for working capital. All moneys received for subscription for shares beyond 4,000, up to the sum of £15,000, to be paid to the vendor. If the full amount be not paid before the 29th August, he will be entitled to require the company to forthwith allot to him or his nominees fully paid ordinary shares, equal to the nominal amount remaining unpaid.

An agreement of 1st Sept. (filed 3rd Sept.) cites that only £1,890 has been paid in cash, and in accordance with the vendor's request the company will allot fully paid shares to the amount of £13,050, being the balance of the £15,000 payable in cash.

**International Okonite Company, Limited.**—The registered office of this company is now situate at 98 and 100, Queen Victoria Street.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Brush Electrical Engineering Company, Limited.

THE first annual general meeting of the company was held at the Cannon Street Hotel, on Monday, the 8th inst., Lord Thurlow in the chair.

The Chairman, in moving the adoption of the report (printed in our last issue) and accounts to the 30th June, 1890, said that as this was the first opportunity he had had of addressing the shareholders at an annual meeting, he might, perhaps, be pardoned for saying a few words in description of the position of the company, and the financial and other results of the amalgamation. Although at the statutory meeting of the company, held on the 25th November, it was reported that the amalgamation with the Australasian and the Falcon Companies had been satisfactorily carried out, yet, perhaps, at that time the amalgamation existed more or less on paper. It had now been made a reality. As regards the reconstruction of the Anglo-American Brush Electric Light Corporation, there was very little to be said beyond what they knew already. The Brush Company retained its works in the Belvedere Road and other places, in fact, everything it possessed, and, in addition, it had acquired some valuable assets. New shares had been issued to the old shareholders, that was to say, the old shareholders had received new shares in exchange for the old at the agreed upon rate. As regards the Falcon business at Loughboro', Leicestershire, no time had been lost in taking those works over, and about £20,000 had been spent in erecting new shops to enable the company to construct the heavy machines it was now called upon to make. As regards the Australasian Company, the original scheme had been that the company should take over the whole of that business, including patent rights and stores, and issue to them £45,500 in shares and £500 in cash. The negotiations had been very protracted, not owing to any unwillingness of either party, but owing to the difficulty experienced in adjusting some of the assets. They were now satisfactorily concluded, but with a certain modification, namely, that the Brush Company, instead of taking over the stores, floating assets and liabilities, agreed to take over only the patents and the shares in the Melbourne Company, and to issue £31,000 in fully paid up shares to them instead of £41,500. Subsequent negotiations which took place had been owing to the inability of the Australasian Company to give a good title to everything that had been scheduled. They were matters of no material importance, but a certain deduction had had to be made on account of them. The financial result had been that the Brush Company took over the patents and shares of the Melbourne Company for £27,500 in shares, two-fifths ordinary and three-fifths preference. Had it not been for the conciliatory attitude of Mr. Van Tromp, the chairman of that company, and the liquidators, the difficulties in the way of the amalgamation might have been insurmountable, which would have been unfortunate. Negotiations were still on foot with a view to the Brush Company taking over the whole of the Melbourne Company's stores. From

the first the Brush Company had said that they would not take over its assets and liabilities, and that decision had been adhered to. The amalgamation had opened up to the company an enormous field for business, and one which would require very considerable energy on the company's part to do justice to. To obtain a fuller grasp of the position occupied by the company in that part of the world the directors had requested Captain Rowan to come over from Australia to advise them on all points. He came, and lengthy meetings had been held, and every point thoroughly sifted. Finally, satisfactory terms had been made for engaging him for a term of years to look after the company's interests and take charge of its business in Australasia. The final result of the issue of shares had been as follows:—To the Anglo-American Brush Company £156,942 ordinary and 104,628 preference shares; to the Falcon Company £33,305 ordinary and £22,200 preference shares; to the Australasian Company £16,500 ordinary and 11,000 preference. The balance of capital appearing in the report and balance sheet had been raised by subscription, making in all an additional £24,192 in ordinary shares and £164 in preference shares; and after all these transactions the company had only £256 10s. as outstanding arrears. They would, he thought, agree that that was a satisfactory result. Those arrears would, he hoped, very shortly disappear. The £75,000 debentures issued by the new company could, of course, only be so with the consent of the existing debenture-holders of the old Brush Company. That had been obtained; that was to say, those debenture-holders had been induced to convert their debentures or they had been paid off. They had behaved in a very friendly spirit, and the debenture charge on these great properties was very light indeed. Those debenture-holders had agreed to take the new debentures with the exception of £7,900, which had been purchased by the liquidators of the old company, and formed a very valuable security for any shareholder who liked to get 6 per cent. for his money. He thought it more desirable to keep those debentures, and, for his own part, would be prepared to take up some, and he strongly urged the shareholders to absorb them. They would be retained by the directors for a time for that purpose, and there would be no difficulty in disposing of them. As to the general efficiency of the combined works which the company now has: The Brush works in the Belvedere Road were in themselves very perfect, and the Falcon works by themselves were extremely satisfactory for the acquisition of work; but the combination of the two for the carrying on of electrical engineering formed an unrivalled position. The situation of the Falcon works was everything that could be wished as enabling the company to obtain the best and most skilled labour and the cheapest fuel. Moreover, they were on one of the main lines of railway, viz., the Midland, the Loughboro' station of which had sidings actually adjoining the company's works. Taken in conjunction with the Lambeth works, they enable the company to distribute its heavy work and its fine work most satisfactorily. The Falcon works occupied about seven acres of freehold land, or 35,646 square yards. About two-thirds of that space was built upon with the old shops taken over and new ones subsequently erected, leaving unoccupied land of about 12,900 square yards. The lifting power provided at the new works was very extensive and complete. The largest size of machine the company at present turned out was the Victoria-Mordey dynamo, and they had already in course of construction a dozen machines of more than twice that size, that was to say, 30 tons. Of course, very heavy cranes were required, and the foundry was fitted with all that. The company was now able to cope with work of almost any magnitude. As regards expenses and profits: the latter appeared in the balance sheet; they would find that the expenses had slightly increased, but that was unavoidable, if they considered the vast body of work done, the expenses of the amalgamation, and of securing these additional works at Loughboro', &c. The expenses had increased from £11,131 in 1888 to £16,000 in the present year, and he did not think he could hold out very much hope of their being much reduced in the future. The directors would do what they could. There had not been, nor would be, any extravagance or want of care and attention. It was one of the inseparable results of extending business. As regards liquidators' balances, £9,979, he thought the shareholders would make their minds quite easy. No less than £7,900 represented the debentures of the old company which had been purchased by the liquidators, and the balance consisted of sundry small debts and accounts. As regards the litigation with the King-Brown Company, they were bound to take the case to the House of Lords for two reasons—first, because the English court of law had originally decided the case in their favour; and, secondly, to justify their having taken royalties from every manufacturer in Great Britain for some years past. Of all other litigation the company had pretty well washed its hands. Then, as regards their policy in reference to a matter of importance second to no other in the electrical world, viz., the obtaining of provisional orders; the directors had, as a general rule, confined their applications to places in which the company had interests to serve, like Bournemouth, Cardiff, and others more numerous than might be supposed. They had acquired the Bournemouth order, and also one-third of the City lighting. The City had been divided for this purpose into three great districts, and the Brush Company had acquired the central one, which was certainly not second in importance to any of the others. The company had to carry out the work under very favourable conditions, and strict but not impossible terms as to date; in fact, it had still some months before it would be compelled to commence the work. The cost of carrying it out would amount to some £300,000, and it formed a very valuable asset. The company em-

ployed some of the most experienced of the men connected with electrical and engineering work. The latter was almost as important as the former, and no company that did not combine to the utmost experience and knowledge of both could hope to carry out satisfactorily such an order as this. As regards the dividend—the profit and loss account showed a gross profit of £36,698, and after deducting all standing charges there remained a balance of £14,235. Out of that the directors proposed to write off £3,000 on account of property and patents, to apply £625 to reduction of preliminary expenses, and write off £500 on account of a small sum of £1,500 spent, and still being spent, in obtaining provisional orders. That left a balance of £10,426 to be appropriated. Out of that, of course, had to be paid dividends due on preference shares for the six months from February 10th to now, viz., £3,505, an interim dividend of £3,808 6s. 10d. having already been paid. Altogether, then, it was proposed to pay a dividend of £7,313 11s. 4d. on the preference shares, and to carry forward a balance of £2,796 to the next account. It was, perhaps, an act of purism to write off £500 on account of that £1,500 for provisional orders and £3,000 on account of the property account. The shareholders were not compelled to consent to it, and in that case they would have £6,800 available for a dividend on ordinary shares. They could if so disposed appropriate and divide a dividend on the ordinary shares for the past twelve months of 3 per cent., after paying the dividend on the preference shares and the debenture charges and every other legitimate expense, and that without taking into account any profits accruing from the Australasian branch. The directors, however, did not recommend that course, but that it should be appropriated as suggested in the balance-sheet. It was necessary the company should occupy in the future a strong financial position as well as a strong manufacturing one, and no company could do so unless it acted on certain recognised rules, one of which was to write off from the property and patents account as much as it could afford, and also a portion of other charges of an exceptional character. The scheme proposed by the directors was in accordance with sound finance. He did not anticipate their having to raise the £300,000 for the City order—the company would be paid on account as the work progressed—but undoubtedly a work of that magnitude could not be entered upon unless with a certain amount of ready money. They must, therefore, not be surprised if required to raise additional money, and should the event occur, it was essential that their last balance-sheet should appear sound. He moved the adoption of the report and accounts.

Mr. Van Tromp, in seconding, said he could give his assurance that the company was on the high road to being a very great success. He had inspected the works at Loughborough, and he did not hesitate to say that, for the purpose, there were very few premises in England better adapted. They possessed appliances which would enable the company to do everything connected with electrical motive power, from the commonest electrical apparatus to a large electrical car, an engine, or anything. The chairman had omitted, with regard to the Australian transfer, to mention that it comprehended the Cape of Good Hope and India. India he looked upon as a future grand field for electric lighting: it was a country of luxury and wealth, of enormous incomes, a very warm climate, in which electric lighting as against gas must be immensely favoured. Nor had any allusion been made by the noble lord to the company's works in Vienna and Austria-Hungary. The former were carried on at considerable profit, which was gradually increasing. The company had a great future in Vienna. As regards the Hungarian business, from the very latest advices received, it was a positive fact that electric lighting was completely beating the old gas company. It was believed that the whole lighting would shortly be in the hands of the Brush Company, to which very large profits must ultimately accrue. The directors would only be satisfied with giving the shareholders not merely a good but a handsome dividend. Everything was now in the most perfect working order.

Mr. Smart, a shareholder, thought the directors ought to be made acquainted with the feeling of the shareholders with regard to the non-receipt of any dividend for some years past. They had heard exactly the same promises for the future as they had done for some years past; but the result to the shareholders had been very different. The chairman said it was a new company; to the shareholders it was merely a change of name.

The Chairman reminded the speaker that the shareholders were getting a dividend.

Mr. Smart said something like 2 per cent.; a nominal dividend, certainly.

The Chairman said there was a dividend of 6 per cent. per annum on the preference shares.

Mr. Smart was not to be deluded. Like every preference shareholder, he also held a large amount of ordinary stock. Their receipts were really under 2 per cent. They felt greatly disappointed.

Mr. Ward would like to hear the charge of £8,000 for salaries explained. He hoped the directors were alive to the importance of electrical traction, and would be prepared to take the lead. Like other shareholders, he was anxiously looking forward to receiving a dividend on the ordinary shares, but he thought the board had done wisely in making the distribution as they had done.

Another Shareholder asked whether failure of the appeal in the King-Brown case would imply that the company would have to refund the royalties actually received by it.

The Chairman, in reply, said he anticipated a great development in the electrical industry to result from the recent removal by

Parliament of restrictions which had been quite prohibitive, and also from the public having become awake to the advantages which electricity offered. He had omitted to include in his former remarks the relative cost of manufacture in London and in Loughboro'. This as regards price of labour, coal, castings, &c., was very considerably in the company's favour. The £8,000 for salaries included those of the manager, sub-manager, skilled electricians, draughtsmen, managers at Loughboro', Vienna, and in Australia; in fact, a vast number of highly skilled men, and everything except directors' salaries and workmen's wages. The electrical tram car business had been beset with difficulties of various kinds, but it was now emerging from those difficulties, and it was one of the objects the directors had had in view when amalgamating with the Falcon Works, which were so admirably adapted for the manufacture of those cars, and which, moreover, placed the company in actual touch with the present users of horse cars, a great number of which had already been turned out by the Falcon Works. Only the other day the company received an order from the London Road Car Company for 60 busses. The works were also well adapted to the manufacture of electrical launches. The company was making a great many engines at Loughborough. The royalties referred to had been received by the previous company, and whatever might be the decision of the House of Lords, they were not recoverable from the Brush Company. All that would happen would be that the company would receive no more royalties.

The motion was then put, and carried unanimously.

The Chairman also moved to declare a dividend on the preference shares of 6 per cent. per annum for the period from 10th August, 1889, to 30th June, 1890; and that the balance dividend (after payment of an interim dividend on the 1st March last) be paid on the 19th September next.

The motion was agreed to, and, with a vote of thanks to the chairman and directors, the meeting dispersed.

**Commercial Cable Company.**—The transfer books will be closed from September 20th to October 2nd, for the payment of the usual quarterly dividend of  $1\frac{1}{2}$  per cent. on October 1st.

**National Telephone Company.**—The committee of the Stock Exchange has ordered 2,284 additional shares, No. 436,701 to 438,984, to be quoted in the official list.

#### TRAFFIC RECEIPTS.

The Great Northern Telegraph Company, Limited. The receipts for the month of August amounted to £25,000; 1st January—31st August, 1890, £181,000; corresponding months 1889, £178,200; do. 1888, £179,300.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 5th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,500.

### BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—LEEDS, 1890.

#### ELECTRIC LIGHTING AND FIRE INSURANCE RULES.

By WILSON HARTNELL.

(Read before Section G, September 8th, 1890.)

**Introduction.**—Every system of artificial illumination involves some risk from fire. Electric lighting, although it may be the safest of lights, is not exempt from this danger.

Until recent years, insurance companies have given their attention to framing regulations for checking the spread of fire when once it had originated, rather than devising means for preventing an outbreak.

The early inexperience and ignorance of many who undertook electric lighting, and consequent accidents, rendered some guidance and restrictions absolutely necessary for protection against fire. No authority existed. The Society of Telegraph Engineers proposed a few obvious regulations which were accepted by the majority of insurance companies as sufficient. Comparatively recently the Electrical Society have framed a much more elaborate, and an admirable set of suggestions. Meantime the Phoenix and many other fire offices have formulated conflicting rules or their own, which they more or less enforce.

I say advisedly, more or less, because on the one hand, in the absence of any comprehensive and competent system of inspection on the part of the insurance companies, and their different requirements, and, on the other hand, in their desire not to lose business, no standard of excellence is attempted.

Much is left to the conscience or ability of the contractor, which is unjust to those who abide by the best rules.

Large numbers of persons and millions worth of property are affected by these rules.

The object of this paper is to point out much needed amendments.

Such rules should be based on the deductions of experiment and the teaching of experience. They should give the utmost freedom of action and encourage progress. They should contain the minimum that is necessary, and this should be strictly enforced. Above all, these rules should be in accordance with the general principles which regulate all successful engineering constructions. For example, if we consider such familiar but different structures as a locomotive engine, a steamer, a bridge, we shall observe that there is no absolute safety in any one of them. Each has been perfected, not by directing the mind to a particular class of facts, but by a judicious compromise between many conflicting necessities, by giving neither more nor less than a just measure to each requirement, and in each case, all this has had to be done with due economy and limited means. In this spirit, all fire insurance regulations should be framed.

**Conductors.**—In regard to conductors, my first point is to show that any attempt on the part of the insurance companies to determine a fixed current density is useless, vexatious, and scientifically wrong.

For any electric light installation it is necessary to limit the fall of potential in the more distant lights. This can only be done by so limiting the current density that there is not the remotest chance of fire from over-heating of the wires. For example, suppose the fall of potential between the brightest and dimmest lamps were limited to 4 per cent., and the most distant lamp was 75 yards from the dynamo, then the mean current density must not exceed 1,600 amperes per square inch. If the distance be 100 yards, 1,250 amperes per square inch; if 150 yards, 800 amperes, and so on. In any electrical installation in a large building, it is convenient to sub-divide the lights into groups, dependent upon their distance, and to adopt a table of wires and lamps on the several circuits corresponding to these mean distances, and thus secure comparatively uniform brightness. If, however, an arbitrary rule, such as 1,000 amperes per square inch be insisted upon, this rational principle of lighting cannot be adopted. It is, of course, necessary to adopt some limits of currents, but these depend upon the sizes of the wires, as it is easily shown by experiment and reasoning that the larger the cable the less must be the current density. However small the current, the smallness of the wires must be limited. For example, No. 20 S.W.G. is perhaps the smallest size that should be used, for fear of mechanical injury. In mansions, &c., where the first cost of wiring is of less consideration, and where the wires are placed out of sight, No. 16 S.W.G. may be the limit of smallness. Such details are best left to private judgment, but should be stated on the insurance policy.

That wires can be made red hot by electricity, and give rise to fires, was one of the most obvious facts thrust upon the notice of the insurance companies, and apparently almost the only one they could imagine or comprehend. This danger has been greatly magnified. It is, moreover, the danger most easy to absolutely abolish by judiciously arranged cut-outs.

The current required to heat wires has been the subject of many experiments. The most complete results published were those of Mr. W. H. Preece in 1888 and of Mr. A. E. Kennelly in 1889.

**Experiments on Wires.**—The smallest wire used in electric lighting is the twin flexible wire, equal in section to that of No. 22, S.W.G. It usually carries one lamp and consists of 23 strands, six mils. diameter. (Specimen silk and asbestos covered.)

This experiment shows that one strand only suffices to light a 110 volt 16 C.P. lamp requiring about 58 amperes. This pendant of 23 such strands is therefore absolutely safe with one lamp.

The current density in this small filament is 20,500 amperes per square inch.

This filament will carry three such lamps, say 60,000 amperes current density, without being hot enough to burn anything. It becomes dull red hot with five lamps and a current density of about 100,000 amperes per square inch. It must be remembered that the heat increases as the square of the current, so that with five lamps there is five times five, or 25 times as much heat as with one lamp. This is an extreme case of high current density. Another opposite extreme case I recollect was that of a lead-sheathed cable carrying about 400 amperes with a current density under 700, the temperature of which was found to be 135° Fahr. on a cold day. These extreme cases illustrate the absurdity of a fixed current density regulation.

Experimenting further with this small stranded twin wire, it will be seen that it easily carries eight or ten lamps—in fact, that it may be used to supply a 200 C.P. lamp. According to Mr. Kennelly's experiments, No. 22 = 28 mils. will require about 17 amperes to raise the temperature 100 degrees in wood casing. This is about 30 lamps of 16 C.P., 110 volts, or 27,000 amperes per square inch, current density.

It may therefore be pronounced to be absolutely safe with two or three 16 C.P. lamps. The current required to make the insulation smoke is about 30 amperes, or about fifty 16 C.P. lamps. The temperature which a wire attains, through which any steady current is flowing, obviously depends upon the facility with which the heat escapes by conduction, convection, or radiation. So that the current which makes a wire red hot or melts a flexible wire may be more or less. (Exp. a 1,500 C.P. lamp with 35/40 = No. 23.)

The smallest solid wire used in electric lighting is No. 20 = 36 mils., which at 2,000 amperes per square inch would carry one

ampère, say two lamps; but would seldom be used for more than one lamp.

This wire, according to Mr. Kennelly's experiments, will require about 23 ampères in wood casing to raise the temperature  $100^{\circ}$ . It will carry, as here shown experimentally, a 1,500 C.P. lamp, and remain comparatively cool, whilst no less than about 80 lamps or 50 ampères are necessary to destroy it. No 16, at 2,000 ampères to the square inch, would carry six lamps, but is here shown to be comparatively cool with 50 lamps.

I have allowed 40 ampères to flow through such a wire for a long time without much injuring it, equal to 70 lamps, or over 12,000 ampères per square inch; to burn off the insulation 100 ampères, say equal to 170 lamps are required. It is therefore absolutely safe to use 10 such lamps, which cause less than  $\frac{1}{100}$ th the heat to set it on fire.

#### SUNDRY EXPERIMENTS.

No. 18 destroyed with 70 ampères.

7/20 insulation melted with 110 ampères.

I have observed 19/16s carrying 180 ampères for hours—about 2,900 ampères current density. It becomes warm—according to Mr. Kennelly's experiment the temperature would be raised some 40 degrees.

The scientific rule is that of the Institute of Electrical Engineers, that the wire is to be at least of such size that double the current would not raise the temperature  $150^{\circ}$ . This limit for an initial temperature of  $75^{\circ}$ , calculated from Mr. Kennelly's formulae gives  $c = 560 d^{\frac{2}{3}}$ , and might well be adopted by the insurance companies.

These experiments on the smaller wires used in electric lighting, made not only with a current meter, but with the lamps before our eyes, have demonstrated that there is not the most remote danger of fire with the currents ordinarily used. That on the smallest wire even 10,000 ampères current density would be safe (as safe as 500 current density on mains for 400 ampères), and that for insurance companies to fix a current density, is useless, vexatious and scientifically wrong.

*Fusible Cut-outs.*—Fusible cut-outs seem to be regarded with some mistrust. The point I desire to establish is that by their means the mains and branches may be absolutely protected from danger by fire.

The highest current will be required to melt a cut-out when it is short, and itself and connection cold—when it is longer or covered up, and heated gradually, a lower temperature melts it.

A sudden rush of about twice the current may pass through, melting the cut-outs explosively.

#### *Experiment of Cut-out melting by Degrees, and Sudden Rush.*

A copper wire will likewise take more than double a dangerous current without harm in a momentary rush. On one occasion I observed a short circuit through a No. 16 wire, throw off a magnetic cut-out supposed to be set at 350 ampères, without damaging the insulation of the wire.

The first point to notice is that the fusible wire melts at less current than the copper wire gets damaged.

The next point is to prove experimentally that wires are efficiently protected by fusible wires of the same diameter; and this is the only point that insurance companies need trouble about. So long as wires are efficiently guarded, it is no business of theirs what the working current may be.

It may be experimentally shown that even larger cut-out wires would protect copper.

But this is bad practice since, in most cases, much smaller cut-out wires can be used—especially in the larger mains.

There is some danger of the flash from a sudden rush lighting inflammable dust, if so fixed that such dust can settle on them.

The subject of the construction and position of cut-outs is most important, but would require a paper to itself.

Experience has led me to regard good cut-outs properly fixed and wired with almost implicit confidence as protecting the wire.

*Contacts.*—In an experience extending over seven years, all the dangers of fire have proceeded from imperfect contacts (with two exceptions). In two cases the wires were cut in two by carpenters, not concerned with electric lighting. In one case a fire arose from the slackening of a binding screw through shrinkage of wood. The resistance of a well-scraped contact is considerable, but loose screwed contacts get hot with even 5 ampère currents. Broken wires with ends in contact are sure to set the insulation on fire through sparking. Insufficient area of contacts leads to heating. Cut-out wire requires specially good contacts to prevent melting at their ends from this cause.

#### *Experiments on Contacts.*

Cut-outs are no protection against heating and sparking from imperfect or broken contacts. The following rules are useful:—Avoid screwed joints as much as possible; screw them up tight, with good areas of contact; on no account allow them out of sight. Solder every connection as far as conveniently practicable.

All sharp kinds in solid wires to be cut out, not straightened. Use standard wires as far as possible. Put no very small wires out of sight.

Intelligent and conscientious workmen are desirable to obviate this contact danger.

Cut-outs must be placed in conveniently accessible positions. Short circuits readily occur at the lamp-holders chiefly from meddlesome curiosity, but are almost impossible elsewhere if the wires are properly fixed and let alone, so that the risk of moving the cut-out from the root of the branch is about zero. It is easy to make this assumed risk absolutely zero, for if the cut-outs be no larger than the branches they protect, each wire has a second protection in the cut-out of the next superior branch.

Experience with cut-outs shows that if only a small margin be allowed, they are after a while liable to melt with the working current, apparently from deterioration of contacts and gradual accumulation of heat. In fact, cut-outs seem only too ready to melt, and are absolutely trustworthy to prevent fire from excess of current.

The insulation required for telegraphic work and that for electric lighting work are not necessarily the same. In the former the wires extend for hundreds of miles, and the storage of energy in the batteries is both costly and limited. In electric lighting the wires are short and power abundant, most engines could easily be improved from 10 to 15 per cent., and the owners will not incur the small expense, so that 1 or 2 per cent. leakage of electricity, which would be considered enormous, is almost of no consequence from a prime mover point of view (so to speak).

The chief object of electric light insulation is safety; and this safety, like that of a steam boiler, should be not for one or two years, but for as many years as possible. Durability is, in my opinion, of far more consequence than high insulation. I therefore consider naked wires on insulators (where practicable) the best of insulation, and I regret to say that I look upon vulcanised India-rubber with some distrust. Exposed to the air, vulcanised rubber often cracks, and more or less perishes in a few years. It may be that when held together and protected from the air, as it is in the cable, it may last for say 20 years or more. For damp places, vulcanised rubber is indispensable, or some waterproof insulation.

Recollecting that all work has to be done with limited means, and at some risk, it is very important to have clearly defined what wires will pass the insurance companies, and under what circumstances, and at what premiums.

Here are specimens of wires by two London and two Manchester firms:—

1. Single rubber-covered wires, which appears to me the least insulation desirable for wires in casings.
2. Double rubber-covered wires.
3. Light vulcanised rubber-covered wires.

The prices of similar qualities by different makers are much the same. But the price of single rubber-covered is 20 per cent. less than that of double rubber-covered, and light vulcanised about 40 per cent. more than double rubber-covered.

Any of these wires when dry, the insulation per square foot in area is very great, and a low insulation means local faults, perhaps one local fault which may be a source of danger. On the other hand, the insulation is very much lowered by damp weather.

To overhaul an installation so thoroughly as to trace and eliminate every slight fault would involve far more labour than is ever likely to be taken. Hence the greatest protection, in my opinion, is to be obtained by using good material and good workmanship throughout, and not trust to merely insulation tests only.

A bad job may test well, and *vice versa*.

It is not fair to demand very high insulation tests for wires without also specifying the quality of insulation. Because a single rubber wire, or possibly a wire innocent of India-rubber, may test as well as vulcanised wire in dry weather.

It must also be remembered that although the insulation of the bases of the switches and cut-outs is high, yet in the aggregate (if the switches, &c., be numerous), they will reduce considerably the total insulation. If the test be between the positive and negative wires, the lamp fittings will greatly reduce this, so also that of the twin wires for the pendants, the insulation of which I have known to vary from 120 megohms per milé when dry to 48,000 ohms per milé when soaked in water and drained.

I find the ordinary twin flexible asbestos, covered, to be 10 to 20 megohms per milé.

Thus, for testing to be fair, it must be stated how the tests are to be made.

*Casings.*—The casings are mechanically useful to protect and support the wires; they have the disadvantage, putting it from an insurance point of view, of concealing it.

They no doubt assist the insulation.

The space between the grooves has now been reduced to a reasonable width, at the same time it seems unreasonable to put all qualities of wire on the same footing. It seems to have been forgotten, curiously, that when switch wires, say positive, are laid on a positive wire and switched off, they become negative. The possible current through them is no doubt limited to that which would go through the lamps.

Seeing how much this practice is followed, and its convenience, it is another argument for the use of good wire, with which under such circumstances accidents are hardly conceivable.

The use of varnishing casing seems very doubtful; if the place be not damp it can be of no service; if it be damp then a wire that will stand damp ought to be used.

Non-inflammable paints, to prevent the casing taking fire, seem

to me ridiculous. There can be no remote risk of fire in the casing, if the work be properly done.

Of switches very little need be said on the main sections, double pole switches are convenient, but on the branches double pole switches and double pole cut-outs, by the extra expense and complication they would entail, would more than defeat any imaginary advantage urged by their advocates.

*Equity of Rules.*—The grievance of ill-framed and conflicting fire insurance rules is not only that they interfere with the carrying out of the work in the manner best suited to the circumstances, but there is difficulty in knowing what is required, by insisting, or appearing to insist, on a certain class of material, &c., in one case, and passing very different things in another; there is a further difficulty in not knowing what they will pass.

Those who require the electric light, and know nothing of the matter, are still further bewildered, and are apt to accept the work which is the least expensive, so that the insurance companies defeat the professed object.

It appears, from some recent correspondence in the *London Times*, that of 33 offices, ten offices use the Phoenix rules, ten others have their own special rules, seven deal with each risk as it arises, six use the Institution rules.

In conclusion, I would most strongly urge that the rules of the Institution of Electrical Engineers, with perhaps a few additions, be accepted by all the fire insurances.

ALTERNATING VERSUS CONTINUOUS CURRENTS IN  
RELATION TO THE HUMAN BODY.

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THE present paper is supplementary to a preliminary paper on the same subject read before the Institution of Electrical Engineers on the 27th March, 1890.

In that paper it was stated (*Soc. Journal*, Vol. 86, 1890), that "our experiments have not been made with the powerful currents dealt with in electric lighting and distribution of power," and this admission together with the difficulties inseparable from the accurate measurement of alternating coil currents are points in connection with our paper which have given rise to much discussion in the electrical and other journals.

In the present instance, however, we have endeavoured as far as possible to obviate criticism on these grounds.

1. By using currents directly from lighting circuits—both alternating and continuous.

2. By using currents directly from a dynamo whose rate of alternation could be accurately ascertained.

3. By using currents of high E.M.F.

4. By using an instrument for the measurement of alternating currents, whose accuracy at the reading of our former paper was theoretically questioned by one or two speakers, but which has since been tested and proved to give correct readings by an eminent practical electrician (see page of *Soc. Journal*, Vol. 86, 1890), thus confirming the accuracy of the readings formerly recorded by the instrument, as well as those which are contained in our present paper.

Another practical point to which special attention has been given in this paper is that our experiments have been made chiefly with the skin in a state of nature, so that the conditions of experiment as nearly as possible resemble those which might be expected to exist under accidental circumstances, that is to say under circumstances when contact with the conductors was unexpected and therefore unprovided for.

With so much brief preface, we proceed to give in detail the results of several series of observations made under the conditions explained at each step.

RESISTANCE.

In dealing with the resistance of the human body many difficulties present themselves and render it by no means easy to arrive at definite data thereon. The complicated structure of the body at once prohibits any attempt to regard it as an ordinary inanimate conductor. Several methods have been tried or suggested. The Wheatstone bridge method which we previously adopted, was shown to be inaccurate by Mr. Otto T. Blathy, in the *Electrician*, of April 25th, 1890, and the unsatisfactory nature of comparisons made between resistance measurements taken with the E.M.F. of a few battery cells and those likely to result from the use of an E.M.F., such as is common in light and power circuits has been pointed out by several of our critics.

We have, therefore, thought it best to obtain our resistance measurements by passing the current direct from a light circuit through two or more bodies in series, and then, by noting the current strength passed and the E.M.F. used to pass it, to calculate the resultant resistance.

For this purpose we used in the first case dynamo generated continuous current taken from the lamp leads at the Institute of Medical Electricity, which is supplied by the St. James's and Pall Mall Electric Light Company. Having disconnected a lamp the voltage was tested, and found by a Cardew voltmeter to be 104. We then connected up two metal electrodes of 45 square centimetres area each, which could be grasped in the hand, putting in series therewith only a milliamperè meter having 755 ohms resistance and a key. Two persons joined hands, and each grasped one of the electrodes with his free hand. Circuit was then completed and the reading taken.

The results are set forth in the following tables:—

TABLE A.—RESISTANCE TO CONTINUOUS CURRENT.

Group.	E.M.F. in volts.	Current strength in M.A.	Total R.	R. of milli-ampère meter in ohms.	Resultant R. of each person.
1, two persons	104	7.5	13,866	755	6,555
2 "	"	5.75	18,086	"	8,666
3 "	"	7.25	14,345	"	6,795
4 "	"	9.25	11,243	"	5,244
5 "	"	9.5	10,947	"	5,096
6 "	"	8.0	13,000	"	6,122
7 "	"	10.0	10,400	"	4,822

Average 6,185 ohms.

In the second case we used a dynamo generated alternating current, taken from a Siemens dynamo at the School of Electrical Engineering, Hanover Square, which was kindly placed at our disposal by the managers (Mr. Wm. Lant Carpenter and Mons. Leon Drügan). The arrangements for connection were exactly the same as those described above for the continuous current, except that groups of four and five persons joined hands instead of only two. The same Cardew voltmeter, the same milliamperè meter, the same electrodes were used.

The voltage varied from 115 to 137 and the alternations from 60 to 75 per second.

TABLE B.—RESISTANCE TO ALTERNATING CURRENTS.

Group.	E.M.F. in volts.	Current strength in M.A.	Total R.	R. of Gal.	Resultant R. of each person.
1, five persons	115	4	28,750	755	5,599
2 "	120	5	24,000	"	4,649
3 "	123	7	17,571	"	3,363
4 "	124	7	17,714	"	3,391
5 "	124	6	20,666	"	3,982
6, four persons	123	8	15,375	"	3,655
7 "	137	9.5	14,421	"	3,416

Average 4,008.

These observations show results widely differing from those obtained by other methods and indicate that while under these conditions the R. to the two forms of current more nearly approximate to one another, yet that to continuous current is still considerably greater than that to alternating. It is interesting to note that the average R. to alternating current obtained by this method closely corresponds to that obtained by Mr. Blathy and mentioned in his letter above referred to. He makes it from 4,000 to 5,000 ohms, and our results show an average of 4,008 ohms. We may state then in round figures that we find the resistance of the human body under the conditions named to continuous current to be 1.5 times that to alternating current.

We next endeavoured to find how far variations of the contact area would effect the result and obtained the following readings:—

TABLE C.

VARIATIONS IN CURRENT DUE TO ALTERATIONS IN CONTACT AREA  
(E.M.F. being constant.)

Continuous dynamo current at 104 volts.

Total contact area in square centimetres. (Two electrodes, each having same area, one being grasped in each hand.)		Current strength in milliamperes.				
90.0	...	Sub. 1 10.9	Sub. 2 10.0	Sub. 3 10.0	Sub. 4 10.0	Average. 10.0
45.0	...	7.25	5.25	7.0	5.25	6.19
22.5	...	6.0	4.75	5.75	...	5.5
9.0	Electrodes held by thumb and finger only.	5.75	3.25	4.0	...	4.3

From this it appears that in round numbers:—

A reduction in the cont. area of 50 per cent. reduces the current strength by 40 per cent.; a reduction in the cont. area of 75 per cent. reduces the current strength by 45 per cent.; a reduction in the cont. area of 90 per cent. reduces the current strength by 60 per cent.

It is manifest that to arrive at anything like a definite law on the subject a great number of readings must be taken, but we think the above results form a useful indication of the important bearing contact area has in determining the seriousness, or otherwise, of accidents in light and power circuits.

SENSATION.

In this part of our paper we propose to compare the results obtained when electrodes connected respectively with dynamo-generated continuous currents and dynamo-generated alternating

current are brought into and kept in contact for an appreciable time with the human skin in a natural state, that is to say, in the state normal to the person experimented upon at the time of testing. In order that this series might be complete, it would possibly have been better to give barometric, thermometric and hygrometric readings, of which we have taken many, but these data belong rather to a complicated side issue and do not affect the main question, to which this paper must necessarily be confined, so we have considered it best to omit them altogether, taking it that the subjects experimented on were in an average condition of health at the time, and that the atmospheric conditions were more or less like those to be expected in a climate similar to that of England.

The results are tabulated as follows :—

TABLE D.

Conditions.—Metal handle electrodes grasped in the hands (surface area 45 sq. c. each) in connection with dynamo-generated continuous current, taken from lamp leads, as before mentioned (Table A.), E.M.F. 104 v., by Cardew's voltmeter.

Subject.	Discomfort point.		Fixation point.	
1	...	18 ma.	...	not any.
2	...	15 ma.	...	not any.
3	...	20 ma.	...	not any.
4	...	22 ma.	...	not any.
5	...	15 ma.	...	not any.
6	...	20 ma.	...	not any.
	Average	18.3 ma.	Average	

In each instance, burning sensation under the electrodes became unbearable after about 30 seconds; this was the only objectionable feature, though electrolytic action was sufficiently marked to induce slight blistering in two of the cases. We have to call special attention to the fact that in no case was muscular fixation, or any sensation approximating thereto, reached with the continuous current, nor have we at present any reason to suppose such a result possible.

TABLE E.

Conditions.—Metal handle electrodes grasped in the hands (surface area 45 sq. c. each).  
Alternating current from Siemens's dynamo. E.M.F. 110 v. by Cardew's voltmeter. No. of alternations per second, 23.

Subject.	Current strength.			
	Discomfort point.		Fixation point.	
1	...	30 m.a.	...	60 m.a.
2	...	35 "	...	7.25 "
3	...	4.5 "	...	6.5 "
4	...	3.5 "	...	8.5 "
5	...	40 "	...	7.25 "
	Average	3.70	Average	7.10

TABLE F.

Alternating current from same dynamo as last table.  
Electrodes, as last table.  
E.M.F. 85 volts.  
Alternations per second 68.

Subjects as before.	Current strength.	
	Discomfort point.	Fixation point.
1	3 5 m.a.	6 m.a.
2	4 5 "	8 75 "
3	3 75 "	8 0 "
4	4 75 "	8 75 "
5	4 25 "	not reached at 8 0 "
	Average 4 15	Average 7 90

In Table E, it will be observed that the average discomfort point is 3.7, the average point of muscular fixation 7.10.  
In Table F, the average discomfort point is 4.15, the average fixation point 7.90.  
The mean of the two sets being 3.9 for discomfort point, and 7.5 for fixation point.  
We wish to differentiate clearly between what we have termed discomfort point in connection with both varieties of current, and that which we have called the point of muscular fixation, which we have only been able to discover in experiments with the alternating current. This is the more necessary,

because herein lies one of the great differences in the danger of accidental contact with the two systems respectively.

To put it plainly, we have found no point at which it is impossible to release personal contact with a continuous current circuit, while it is easy with a comparatively low current strength to find a limit beyond which it becomes a physical impossibility to disengage oneself from contact with the alternating current circuit.

A little consideration will show that this cannot be too strongly emphasised, for while with the one, personal effort will suffice to release the sufferer, with the other the agency of a second person must be called into play before the dangerous action of the current can be stopped.

Many of the critics of our former paper appear to have failed to recognise this most important distinction, and to have regarded muscular fixation as synonymous with discomfort point.

Tables E and F were constructed from observations made on the same patients in the same order with the same machine, though with an interval of two days; in the first table the E.M.F. was greater (110 v.) and the rate of alternation less (23 per second) than in the second table, when the E.M.F. was 85 v., while the alternations were 68 per second.

In Table E fixation needed nearly twice as much current strength as discomfort, and in Table F the same sort of relation obtains, though in the latter instance the alternations were just three times as frequent.

During the discussion on the paper at the Electrical Engineers, on March 27th, Dr. Harries, in his reply, stated that "the more rapid the alternations the more nearly did the conditions resemble those present with continuous current as regards sensation." Putting aside for the moment the difference of E.M.F. in the two sets of experiments (25 volts) a comparison of Tables E F will fully bear out this statement, for we find that both average discomfort points and average fixation points are higher, though the alternations are so much more frequent in Table F.

It may not be out of place here to note that observations made with a Wheatstone's transmitter in another series of experiments, at about the same time, showed that a higher rate of alternations, with same E.M.F. and current strength, reduced the sensation.

It is conceivable and probable that nerve impulses travel as waves at a given average rate of speed (90 feet per second, Helmholtz). But sensations may follow one another so rapidly and so irregularly that one set of waves may impinge upon and modify the next preceding set, thus altering the total effect which would be produced upon cortical centres by a given number of sensations in a given time.

Alternations may be so rapid and irregular that these conditions are present in such wise, that the total effect of a series of shocks given at a certain rate of speed is less than the total effect of a similar number of shocks given at a lower rate of speed.

And it is only in this way that we are able to account for the power to bear larger current strength at a high rate of alternation, i.e., when the rapidity is over 50 or so per second.

SHOCK.

With continuous current shocks (sudden make or break), from dynamo-generated continuous lighting circuit with a current strength of 10 to 20 ma., the sensation was that of a sudden jerk, followed by feeling of heat at the points of contact with the electrodes, increasing until the sensation became unbearable. The make jerk was distinctly more marked and more unpleasant than the break jerk, though the latter was followed by an increase in the sensation of heat in the neighbourhood of the points of contact—the increase persisting for two or more seconds after contact was broken.

Shocks of alternating current from Siemens's dynamo-generated alternating circuit were also taken by the subjects concerned in Tables A, B, C, &c. A tingling sensation was felt, which rapidly increased to muscular contraction, becoming more and more unpleasant, and accompanied by a sensation of heat in the neighbourhood of the electrodes, though not immediately under the site of contact as in the case of the continuous current.

It was noticed that the maximum effect was not immediately felt, an increase being apparent for one or two seconds, the hands being still in contact with the electrodes. This effect was most apparent with small currents (2 to 3 ma.). As the current strength increased the maximum effect was more rapidly produced.

When 8 ma. were passed the effect seemed immediate. Considerable heating of the parts in contact with the electrodes, and of contiguous parts, was noted on both make and break shocks. This continued to invade adjacent parts during the period of continued closure of the circuit, and the general effect included muscular fixation in most of the subjects experimented on.

In our previous paper we concluded by deducing a danger ratio. This showed the danger of serious consequences on contact with the alternating current to be 41.5 times greater than that to continuous currents. So high a ratio was thought by many to be excessive, and the more recent experiments now set forth prove it to be so, if we calculate it on exactly the same lines as before. We find, however, that there are other factors which should be included in calculating the danger ratio, in addition to those used in the former paper, viz., "Differences in Resistance and Sensation." The difference in resistance obtained by the method we have now adopted and set forth in Tables A and B is 1.5 instead of 8.3, as obtained by the former method. The difference in sensation set forth in Tables D and E, on the other hand, is 4.7, or only 0.3 less than that obtained previously. This would give a danger ratio of 7.0. Such a ratio, though far below that obtained with small battery and coil currents, would be sufficiently serious to demand

very careful attention from electrical engineers, if it represented the whole state of the case; but it does not (as mentioned above) cover the whole ground, for we have also to consider two other factors, viz., difference in initial shock and difference in continued contact. On these two heads comparative values cannot be given. As regards initial shock, in which the time period of contact is a minimum, we have made many tests on various individuals, who one and all declare that the initial shock of alternating current of a certain strength is far worse to bear than the initial shock of continuous current of the same strength. This, from the nature of the experiments, can only be tested with small currents, and it is conceivable that with large currents such marked differences may not be observable, the time factor being left out of consideration. The second, however (continued contact) is a matter of far greater importance, as we have already pointed out in discussing muscular fixation. The time period of contact being appreciable with continuous current, we have no muscular fixation, and the subject of accident would be able to release himself. On the other hand, an appreciable time of contact being made with an alternating current circuit, the subject would be absolutely fixed *in situ* until released by extraneous aid, being exposed during the whole time to the full effect of the current passing through him. Further than this, the act of muscular contraction might, and probably would, increase the contact area, and so increase the current allowed to pass.

When, therefore, we take these last-named factors into account, it is manifest that the danger ratio of 41.5 to 1, named in our former paper, is by no means too high. We do not now name another figure, because it appears to us impossible to express in terms that could be used for calculation the differences in initial shock and in continued contact.

It may perhaps be expected that we should make some reference to the quantity of current which constitutes a fatal dose, but this can only be arrived at by careful observation of all the electrical conditions prevailing at fatal accidents or executions.

The difficulty of obtaining such information is generally very great as regards accidents, but surely not as regards executions. That the authorities in charge of Kemmler's execution failed to take measurements of the E.M.F. and current strength used, is almost incredible, and in view of the fact that they possessed so excellent an opportunity, such neglect seems quite inexcusable.

For some time past, we have been hoping that some information in this direction would be forthcoming, but the article by Mr. C. Huntley in the *Electrical World*, reproduced in the *ELECTRICAL REVIEW* for September 5th, 1890, appears to be conclusive, for it says, "No data of either the electrical or mechanical apparatus were taken."

Mr. Parry in his recent articles in American electrical papers, arrives at the conclusion that one ampère is an undoubtedly fatal current, provided it actually passes through the victim. This estimate we see no reason to differ from, though we hardly think sufficient evidence has been obtained on which to base definite conclusions.

We will now briefly summarise our conclusions, and in doing so desire to draw attention to the fact that they are based upon certain conditions, and, while we believe them to be sufficiently accurate and reliable under these conditions, we in no sense claim them as true under all conditions.

#### CONCLUSIONS.

A. When the human body, with the skin in its normal unmoistened condition, comes into contact for an appreciable time with bare metal conductors of a dynamo-generated continuous current passing at 100 volts in such a way that the current passes from hand to hand, and the total contact area is about 90 square centimetres.

1. A current of about 0.016 ampère will pass through it.
2. This current can be borne without discomfort for 15 to 30 seconds.
3. After about 30 seconds unpleasant burning sensations become marked and quickly increase.
4. The subject is perfectly able to release himself at will during any portion of the time of contact.

B. When the human body comes into contact with dynamo-generated alternating currents, alternating at about 60 to 70 per second under the same conditions as above.

1. A current of about 0.025 ampère will pass through it.
2. This current is six times greater than that which produces discomfort.
3. Instantly the subject is fixed by violent muscular contraction and suffers great pain.
4. The subject is utterly unable to release himself, but remains exposed to the full rigour of all the current that may be passing.

C. When circuit from electric light or power conductors is accidentally completed through the human body, the danger of serious consequences is many times greater when alternating than when continuous currents are passing at equal voltage, and this is still to a large extent true if the voltage of the continuous current be double that of the alternating.

D. 1. With both forms of current a reduction of contact area materially reduces the amount of current strength that passes.

2. With the alternating current, if the rate of alternation be reduced below 50 per second, the sensations of pain accompanying muscular fixation will be increased, while if the rate of alternation be increased, the pain will be diminished.

Finally, we would remind those gentlemen who so commonly speak as if voltage were the chief or only factor in the danger of accidental contact, that current strength is the important item, and

that according to Ohm's law current strength is dependent not only upon E.M.F., but upon the total resistance in circuit at the time of accidental contact.

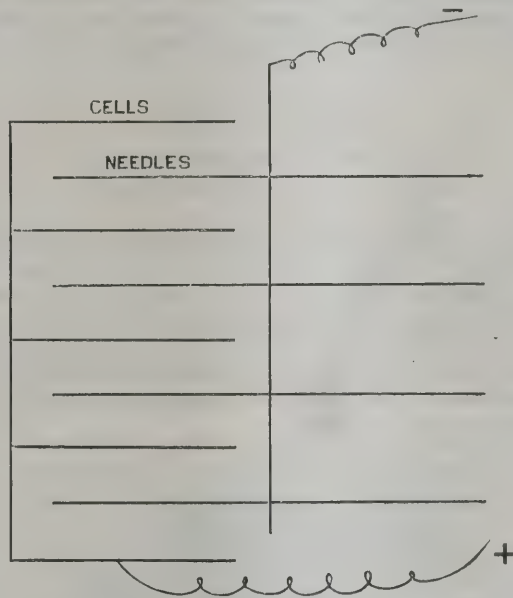
To make statements based upon voltage only, such as newspaper reports of a recent execution have contained, is not only distinctly misleading, but calculated to induce the uninitiated to form erroneous conclusions.

#### ON AN ILLUSTRATION OF CONTACT ELECTRICITY PRESENTED BY THE MULTICELLULAR ELECTRO- METER.

By Sir WM. THOMSON.

(Read before Section A, September 4th, 1890.)

CONTACT electricity of strong metals absolutely removed from possibility of chemical action is a subject which was formerly much discussed, but now the fact of that kind of action is thoroughly admitted, and most of the natural history of the subject is pretty well known. I have not to-day to add to the knowledge of the subject, but merely to remark that it brings out a very curious feature in electrostatic instruments, in illustrating its application to this instrument of contact electricity. The metals in question are brass and aluminium. I am sorry I cannot show you the interior of the instrument just now, but a sketch will probably make it understood. The instrument consists in a multicellular electrometer. In its working it is a number of cells, as the designation indicates, with a needle, or a number of needles, moving under the influence of these cells. There are 20 cells, one over the other, and we will represent this in section.



There are 10 cells acting on one set of ends and 10 at the other. The needles are mounted one above the other on a stem, which hangs by a fine platino-iridium wire. The principle is simply this—the needle is connected through its fine wire with the outside case of the instrument, which is one of the metals between which the difference of potential has to be measured. The other metal is the cells—this pile of cells and the other pile of cells are metallically connected. They are insulated from the outer case of the instrument, and we have a binding screw here connected metallically with the cells, and insulated from the case of the instrument we have another binding screw. The instrument is adapted to measure difference of potential between these two metals. It is analogous to the quadrant electrometer with its needles and quadrants used as two bodies, the needle connected with the case of the instrument. In the quadrant electrometer contact electricity was illustrated by making the two pairs of quadrants, say, of zinc and copper. I have noted a very different manifestation of contact electricity presented by this form of electrometer. Let us suppose that the needles and the cells are maintained at a difference of potential of, say, 100 volts, this instrument before you is adapted to work at potentials of from 60 to 120 volts. If the needles were polished aluminium and the cells polished aluminium, we should have none of the difference due to contact electricity. You get apparently 100 and  $\frac{1}{10}$ ths or 100 $\frac{1}{10}$ , when the needles are positive and the cells negative; on the other hand, when the needles are negative and the cells positive, you get 99 $\frac{1}{10}$ , the mean being correctly 100 volts. I anticipated this when the instrument was first made, but our first trials of all first instruments within the year of preparation showed such effect to a degree so little that it could barely be perceived. You could barely see  $\frac{1}{10}$ th of a volt difference. We made more than a year ago a great many careful experiments, and never found more than  $\frac{1}{10}$ th of a volt. Quite lately my attention was recalled to this by my former assistant, Mr. Rennie, now of the Board of Trade testing laboratory which has lately been established under the superintendence of Major Cardew. He found, with a new instrument recently supplied to that laboratory, a larger difference of just about the

amount we originally expected. I have tried new instruments since, and found it much greater than in the earlier trial instruments. The explanation is, that in the original instruments that were made for trial, with pieces of metal that had been tossed about in the laboratory, and with needles and plates unpolished, the condition of surface was not such as to give the proper difference. But in the finished instruments, with a high polish a definite difference of this kind, much greater than in the original trial instruments, was obtained. I received a letter this morning from Mr. Rennie about experiments on an electrometer at the Board of Trade.

In the course of these experiments at the Board of Trade, extending over a month or six weeks, and made at frequent intervals, there were doubled differences amounting from '5 to '6. There was evidence of a slight decrease in the error, and it is not at all improbable that in time this error may diminish when the initial state of polish may have become toned down. I made one experiment of that kind, subjecting an instrument, just as it stood, both cells and needles, to damping by vapour of water; but the result was not to diminish the difference, but rather to augment it. But exceedingly little change takes place. The explanation is, of course, that polished aluminium is positive to brass, just as zinc is positive to brass, and the effect is of the same kind as would be observed if we had zinc needles and copper cells, the form of contact electricity with which we are most familiar. Let us suppose, instead of being connected to a battery, a metallic connection is made between the cells and the needles; then we shall have a simple contact difference between aluminium and brass. A direct experiment on the force due to that would show no result. Let us say  $\frac{1}{2}$ -volt is the difference.

The force due to this difference when the terminals are metallically connected bears to the force due to it, when a difference of 100 volts is maintained between them, the ratio of  $(\frac{1}{2})^2$  to  $(100 + \frac{1}{2})^2 - 100^2$ , or, approximately, 1 to 800.

#### SECONDARY CELLS.

By W. J. S. BARBER STARKEY.

(Read before Section G, September 8th, 1890.)

I SHALL only try to give a few of my personal experiences with secondary cells without attempting to go into their theory or construction, and I do this more in the hope that it may lead to some interesting discussion, than for any value which may be attached to my experiences. Soon after the introduction of M. Faure's cells into this country I was fortunate enough to become possessed of one, which for a time gave excellent results, but it so happened I had to go away from home for six months, and on my return I found the cell would no longer work satisfactorily, and had become very inefficient.

To find out the cause of this I removed the plates from their felt envelopes, and found that they were partially covered with a white hard sulphate of lead, which I was unable again to reduce; I also found that it had eaten into the supporting plates, and that there was a thin film of white sulphate between these plates and the active material, which practically acted as a non-conductor. This seemed to me such a serious defect that I determined if possible to find out a remedy, and, after numberless ineffectual attempts, I at last found out that if a small quantity of carbonate of soda was added to the dilute acid, it not only allowed the existing sulphate to be again reduced, but it also prevented the formation in future of the hard white intractable sulphate, even if the cells were allowed to stand idle for any length of time. I have allowed plates to remain idle in this solution for more than 18 months, without the slightest trace of white sulphate appearing. Five years ago next Christmas, a small installation consisting of twenty-two E.P.S. 350 ampere-hour cells was fitted up for me, and it so happened that the dilute acid was by mistake put into the accumulators a considerable time before the engine was ready to run, by which time the plates showed signs of sulphating, and as I had only a small current of 10 amperes at my disposal, I was not able again to bring the plates to their proper state, and the sulphating became worse and worse, till all the plates presented a dull grey appearance. I showed them to several electrical experts, and the opinion was that they were ruined, and the only suggestion was that I should pass a heavy current for a long time through the cells. This I was unable to do with the power at my disposal, but I passed a current of 10 amperes continuously through them for a week without the slightest apparent results. Seeing this treatment was hopeless, I then determined to try the carbonate of soda which I had used on a small scale some years previously on the Faure cell. I was told that I should probably ruin the cells, so I began cautiously. Into one cell out of the twenty-two I put a small quantity of carbonate of soda (ordinary washing soda), and I then went on charging as before, and before many hours had elapsed I was delighted to see that the plates in the cell, to which carbonate of soda had been added, were beginning to assume their proper appearance, the positive plates becoming a very dark brown peroxide, and the negative plates a clear metallic lead, which was a great contrast to the uniform dull grey appearance of all the plates in the other cells. As soon as I was convinced that the treatment with carbonate of soda was satisfactory, I added it to all the other cells, with the result that in a short time every trace of the formerly intractable white sulphate disappeared, and the cells presented a beautiful appearance. It is now nearly five years since the cells were thus treated, and

they have never since shown signs of sulphating, and are apparently in as good condition now as when new. I was so much impressed with the use of carbonate of soda to prevent sulphating of the plates, that I brought the matter before Mr. Preece, and he very kindly came to look at the cells, and afterwards carried out a most careful series of experiments to determine the value or otherwise of using sulphate of soda in secondary cells. The results of these experiments are, I believe, well known, and have been published, and the exact amount of carbonate of soda which it is desirable to use has been determined: it is only necessary to use a very small quantity to effect the desired purpose. If much is used it is of no advantage, and may tend to cause scaling of the plates. Now that it is no longer necessary to pass a heavy current through cells, to prevent sulphating, it appears to me that it would be much more satisfactory to use larger cells for stationary work, and both charge and discharge them at a considerably lower rate than at present recommended, thereby enormously increasing the life and efficiency of the cells, and leaving a large surplus of energy in case of emergency. My own cells have been treated in this way, and I cannot see that they have in any way deteriorated after nearly five years' use. If the plates are kept free from sulphate, they may be bent to a considerable extent without suffering any damage, and if the grids are made of pure soft lead they may be readily straightened again. Certainly my experience leads me to recommend the use of soft lead grids in preference to those of a hard and brittle alloy. I consider that burning the lugs together is the most satisfactory way of connecting up the cells, but if brass screws and nuts are used they can be greatly protected by pressing some lead foil over and around them, this will keep off any acid spray which might reach them while the cells are being charged, and should any of the brass connections become corroded, I have found that they can be effectually cleaned without trouble by immersing them for a time in a solution of carbonate of soda, and then washing them thoroughly in pure water. If it is desired to use separators between the plates, a very simple and cheap way to make them is to use perforated porous paper which has been saturated in melted paraffin wax, this stands well in dilute acid, and I have some which have been in use for several years.

Although secondary batteries are now undoubtedly very efficient when carefully used for stationary purposes, it appears to me that as at present constructed they will not stand for any long period the wear and tear, shaking and washing of the liquid against the active material to which they must be subjected when used for traction purposes; at least such is the impression left on my mind after inspecting cells which have been used for even a short time; some of the plates generally soon show signs of buckling, and the bottoms of the cells became covered with disintegrated particles of the active material, which forms a sort of mud. I have endeavoured to overcome these defects by packing the plates in a solid though porous mass of plaster of Paris mixed with sawdust, and for three months a battery of 96 cells thus prepared was successfully running a tramcar at Canning Town and doing the same work as the other cars, however, at the end of this time the management passed into other hands, and I hear that the cells have been taken to pieces, as they were not giving satisfaction, so for the present this experiment has come to an end, and is apparently a failure, but I have not given up hopes that some modification of this plan may be successful, as for a time the working was very satisfactory. The proportion of plaster of Paris used in this experiment was two of plaster of Paris to one of sawdust, but I think the plaster of Paris was not pure, and its proportion was too great. I am now using a set of 22 Elwell-Parker cells, in which the proportion is  $2\frac{1}{2}$  of sawdust to 1 of plaster of Paris. The way I prepare the cells is to mix the plaster of Paris and sawdust intimately together in a dry state, and fill in the spaces between the plates with this mixture. I then pour in gently some dilute sulphuric acid to which a little carbonate of soda has been added, when the whole sets into a compact porous mass. After a time I pour in the electrolyte till it stands above the level of the tops of the plates, and it will be found that the cells will contain nearly as much liquid as if no porous material were used.

Last autumn I used a set of these cells in conjunction with a turbine and dynamo, and although they were last charged in November, I found on my return this year in June that they still retained the charge well after seven months' rest, and burnt the lamps brightly, the E.M.F. of each cell being just under 2 volts. Although in my experiments I have used plaster of Paris to insulate the particles of sawdust from each other, and to give stability to the porous mass, I have tried many other substances, both soluble and insoluble, mixed with it, but sawdust appears to act as well as anything which I have yet tried, and it has the advantage of being cheap, and easily procurable. This method of treating the cells would appear to be of no advantage in stationary work for electric lighting purposes, and would indeed be a distinct disadvantage, as owing to the want of free circulation of the liquid, the E.M.F. falls more rapidly under a long-continued heavy discharge, but it immediately recovers with a short interval of rest, and, in practice, these intervals are constantly occurring in electric traction, when the car stops to take up and set down passengers, and with cells treated in this way the vibration and shaking of the car is a positive advantage, as it facilitates the circulation of the electrolyte, and tends to liberate any occluded gases. The defect of this arrangement would appear to be that it must hinder the free circulation of the liquid and also add to the internal resistance of the cell, whilst, on the other hand, it prevents the plates from buckling, retains the active material firmly in its place, preserves the plates from injury, and

makes the cell very portable. I have ventured to mention this crude experiment in the hope that it may induce someone to produce a thoroughly practical cell for traction purposes which will stand rough usage and be free from the defects which at present exist.

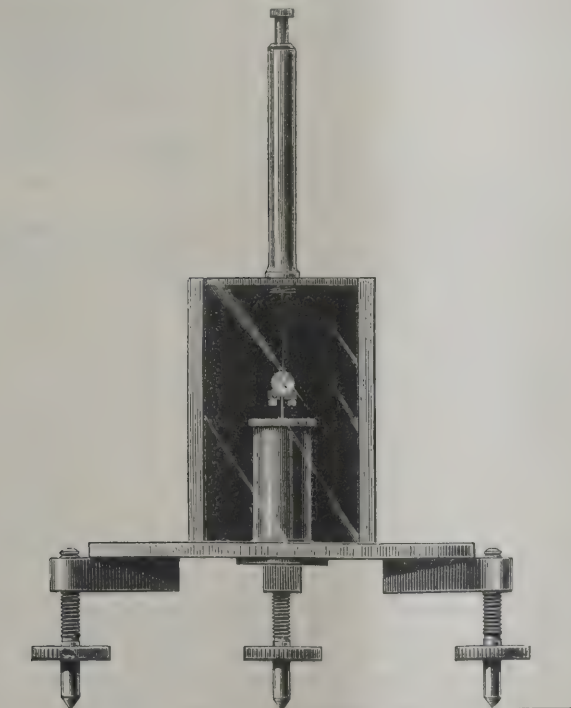
As regards the use of carbonate of soda in secondary cells, a case has just been brought to my notice which appears worthy of mention. I am told that at the Central News office, Ludgate Hill, 28 L. 13 cells had been lying dry and idle for upwards of two years, and each plate was encrusted with hard white sulphate: with ordinary dilute sulphuric acid and a charging current of 10 to 15 ampères, no difference was seen after two charges of eight hours per day; after adding about half a pint of strong carbonate of soda solution to the dilute sulphuric acid in the cells and doing the same electrical work as before, the plates were observed to change colour in a few hours, and in a few days each of the cells presented a beautiful appearance, not a single plate buckled, and I am told that the battery is working perfectly now. This entirely confirms my experience. After plates have been brought to a good condition by the use of carbonate of soda, the ordinary dilute sulphuric acid may be substituted for the mixed electrolyte if the cells are to be used for continuous work; but I believe a small amount of sodium salt is always beneficial; it, however, only becomes a necessity where cells have to stand idle for long periods.

ON THE CHARACTER OF STEEL USED FOR  
PERMANENT MAGNETS.

By W. H. PREECE, F.R.S.

(Read before Section A, September 9th, 1890.)

In the discussion which followed the reading of Dr. John Hopkinson's Presidential address to the Institution of Electrical Engineers, I took the opportunity to point out that the quality of magnetic steel in England had deteriorated, and that it was not to be compared with that produced in France in 1881. This statement was questioned at the time, and I determined to make an exhaustive test of the various steels that are now in the market. Specimens were therefore obtained from the leading firms in Sheffield, viz., Messrs. Joseph Ashforth and Company, Messrs. Saunderson Bros. & Co., Messrs. Thos. Jowitt and Sons, Messrs. Vickers, Sons & Co., and Mr. G. P. Wall, and also from the following manufacturers in France: M. Marchal and M. Clemandot. Mr. Webb, of Crewe, also gave me some samples of the steel used in those works.



MAGNETOMETER.

The magnetometric method has been followed throughout this enquiry. Square bars, approximately 10 cm. long and 1 sq. cm. in section, were chosen as test pieces in preference to the long wires, ellipsoids, or other special forms of magnet usually employed in very accurate investigations. These bars are comparable in dimensions with the magnets actually employed for telegraphic purposes; they are very convenient for use with the magnetometer, they can be kept in a relatively small compass for periodical testing, and they enable us to compare the magnetic qualities of different steels with very great accuracy. Although they can only be regarded as approximately solenoidal, and are much too short for theoretical exactness, yet it is believed that the values of the induction, intensity of mag-

netisation, and specific magnetism, calculated from the magnetic moments of the various specimens, are sufficiently accurate to be of scientific interest. In order to facilitate calculation, it was desirable that the bars should be exactly 10 cm. long, by 1 sq. cm. in section, but it was found that the specimens received could not be worked to this size. I have therefore determined their dimensions and weights by careful measurements, and have given the details in the subjoined tables.

All the English specimens were carefully and uniformly tempered in water in accordance with our usual practice. Of the four magnets made of Allevard steel two were tempered in water, and two in mercury. The Clemandot compressed steel and the Marchal magnets were already tempered and magnetised when received from Paris.

For magnetising the bars a powerful electromagnet (of a form suggested by Prof. Perry) was employed (fig. 1).

The coil of the electro-magnet is wound with 136 turns of .508 c.m. copper wire, the length of the coil between the cheeks being 9.3 cm. The soft iron core is 10 cm. long and 3 cm. in diameter, and the pole-pieces are 11.5 cm. long and 3 cm. square. The upper pole-piece (which may be removed and replaced by one of a form suitable for maximum induction experiments) is furnished with a thumb-screw and a small movable block, so that the bars to be magnetised may be clamped in position, care being taken that their ends make perfect contact with the pole-pieces.

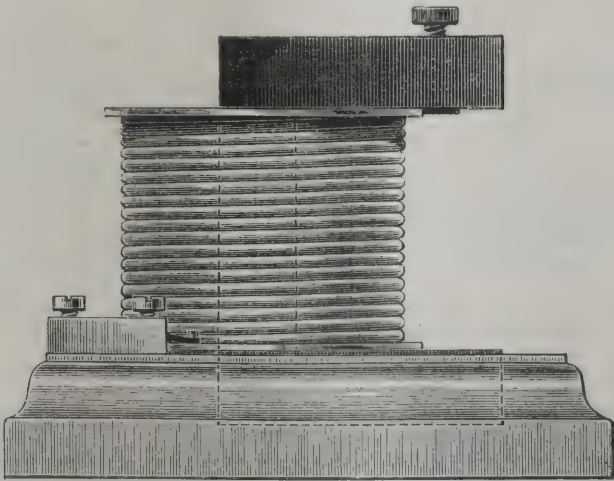
In the first series of experiments the magnetising current employed was 100 ampères (13,600 ampère-turns), and it was kept on for 30 seconds for each bar.

In the second series the current was increased to 325 ampères (41,200 ampère-turns), and kept on for three seconds in each case. Generally speaking this increased current did not increase the permanent magnetisation of the bars; but, on the contrary, the magnetisation was, in most cases, apparently slightly less than it was after magnetisation with 100 ampères three months previously. The magnetisation of the Clemandot and Marchal magnets was, however, considerably increased by the same treatment, as will be seen from the tabulated result of the experiments.

The magnetometer employed is simply a Thomson mirror, suitably mounted with levelling screws, and placed over the centre of a millimetre scale two metres long. The scale for reading the deflections is of the usual straight kind with central zero, and is placed at a constant distance of 100 cm. from the mirror. The magnets were, in most cases, tested with their centres at distances of 100 and 75 cms. from the mirror, and the mean of readings on either side of zero in each position was taken. The moments have been

calculated from the formula:  $M = \frac{H}{2} \frac{(r^2 - l^2)^2}{r} \tan. \theta$ ;  $r$  being the distance of the magnet from the mirror, and  $l$  half the length of magnet (= 5 cms. very nearly).

The maximum value of  $2 \theta$  being only about  $4^\circ$ ,  $\tan. \theta$  has been taken as equal to  $\frac{\tan. 2 \theta}{2}$ .



MAGNETISING ELECTROMAGNET.

The value of  $H$  for the room in the General Post Office in which the first series of experiments were made was determined both by the coil method and by the method of vibrations.

1. Experiments with a coil of 18 turns, and a mean radius of (15.6) cms.:—

Date.	Current.	Distance of coil from mirror.	Deflection.	Tan. $\theta$	H.	Mean value of H.
	Ampères.	mm.	mm.			
June 12th...	5	1,000	21.01	.01047	.1268	.1276
" " " "	53	600	96.14	.04803	.1275	
" 15th ..	5	1,000	20.93	.01046	.1269	
" " " "	47	750	44.79	.0224	.1285	
" " " "	44	600	79.53	.03965	.1282	

TABLE I.  
RESULTS OF EXPERIMENTS FOR DETERMINING THE MAGNETIC MOMENTS, &c., OF VARIOUS KINDS OF STEEL.  
First Series.—June, 1890.

Name of manufacturer.	No. of specimen.	Weight.	Mean area of poles.	Length.	Volume.	Mean moment. M.	Specific magnetism.	Intensity of magnetisation (I)	Induction (4 π I) B	Mean induction of specimens made from each kind of steel.	Remarks.
		Grammes.	Sq. cm.	c.m.	cub. cm.						
Wall ... ..	1	67·279	·8503	10·025	8·525	985·4	14·65	115·6	1452	1524	Steel splits in tempering.
	2	67·235	·8513	10·04	8·547	962·0	14·31	112·6	1414		
	3	66·252	·8446	10·02	8·463	1032·5	15·53	120·8	1517		
	4	66·648	·8487	10·01	8·496	1158·5	17·38	136·4	1713		
Ashforth ... ..	1	75·228	·9295	10·00	9·295	1380·5	18·35	148·5	1866	1710	
	2	76·265	·9436	10·00	9·436	1274·5	16·71	135·1	1697		
	3	75·870	·9365	10·00	9·365	1101·5	14·52	117·6	1478		
	4	76·247	·9398	10·03	9·426	1348·8	17·69	143·1	1798		
Saunderson ... ..	1	77·962	·9712	10·04	9·750	1258·4	16·14	129·1	1622	1444	One specimen split slightly in tempering.
	2	77·800	·9749	10·03	9·770	1051·0	13·51	107·6	1351		
	3	76·955	·9645	10·03	9·674	1048·7	13·63	108·4	1362		
	4	77·145	·9634	10·03	9·662	1107·8	14·36	114·7	1441		
Jowitt ... ..	1	73·928	·9186	10·04	9·222	972·0	13·15	105·4	1324	1522	
	2	74·120	·9249	10·03	9·276	1303·7	17·59	140·5	1766		
	3	72·058	·8995	10·03	9·022	1010·8	14·03	112·0	1407		
	4	73·840	·9214	10·03	9·241	1170·9	15·86	126·7	1592		
Vickers ... ..	1	68·631	·8811	10·04	8·846	792·1	11·54	89·54	1125	1158	One specimen failed to stand tempering, one slightly split.
	2	70·043	·9010	10·03	9·037	934·9	13·35	103·5	1300		
	3	66·651	·8589	10·02	8·606	718·7	10·78	83·52	1049		
Crewe "rivet steel"	1	75·751	·9731	9·98	9·711	149·6	1·97	15·40	193·5	180·6	
	2	75·820	·9790	9·97	9·760	162·3	2·14	16·63	208·9		
	3	75·553	·9736	9·97	9·706	149·6	1·98	15·41	193·6		
	4	77·210	·9909	10·00	9·909	99·88	1·29	10·08	126·6		
Crewe "spring steel"	1	75·012	·9763	10·02	9·783	1093·3	14·58	111·7	1404	1364	Two specimens failed to stand tempering; other two badly split.
	2	76·086	·9837	10·02	9·857	1039·0	13·65	105·4	1324		
Clemandot ... ..	A1	79·518	—	9·90	9·914	872·9	10·98	88·07	1106	1116	These bars are of compressed steel, tempered and magnetised by the maker; they are rather roughly finished and their dimensions could only be approximately determined. Tested as received from Paris.
	2	80·335	—	9·95	10·04	968·6	12·06	96·48	1212		
	3	80·208	—	9·98	10·03	956·9	11·93	95·41	1199		
	4	79·94	—	9·96	9·993	1127·1	14·10	112·8	1417		
	5	80·542	—	9·97	10·07	1010·8	12·55	100·4	1261		
	6	79·958	—	9·96	9·995	1284·1	16·06	128·5	1614		
Marchal ... ..	B7	80·322	—	9·88	10·04	741·2	9·227	73·83	928	1839	Compressed, but untempered.
	1	78·478	·9917	10·00	9·917	1750·7	22·31	176·5	2218		
	2	80·253	1·011	10·00	10·106	1556	19·39	154·0	1934		
	3	79·380	1·014	10·00	10·136	1372	17·28	135·4	1701		
	4	79·540	1·001	10·00	10·01	1645	20·68	164·3	2065		
	5	78·260	·9992	10·00	9·992	1200·5	15·34	120·1	1510		
"Allevard" ... ..	6	79·488	1·0006	10·00	10·006	1279·8	16·10	127·9	1607	1318	Tempered and magnetised by the maker. Tested as received from Paris.
	1	79·900	·9996	9·86	9·856	878·9	11·00	89·17	1120		
	2	80·415	1·0064	9·87	9·934	1199·4	14·92	120·7	1517		
	3	79·600	·9944	9·89	9·835	1480·5	18·60	150·5	1892		
	4	79·765	1·0054	9·90	9·954	1138·6	14·27	114·4	1437	1661	Tempered in mercury.
											Tempered in water.

2. Experiments with glass hard magnetised wires.—H calculated from the formula,  $H^2 = \frac{8 \pi r k}{T^2 (r^2 - l^2)^2 \tan \theta}$ .

June 15th.	Moment of inertia K.	r.	Deflect.	Tan. θ	Time of complete vibration, T.	H.	Mean.
No. 1 wire..	5·6421	Min. 400	Mm. 17·58	·00879	Secs. 7·075	·1278	1·277
2 „ ..	5·574	„	12·14	·006069	8·462	·1278	
3 „ ..	5·574	„	17·48	·008738	7·062	·1276	

The values of H thus obtained, although agreeing closely with each other, being surprisingly low, the same wire magnets were taken to a spot 4 or 5 miles from the G.P.O., and it was then found that their periods of vibration were reduced respectively to 5·99, 7·14, and 5·95 seconds, making H about ·1782, and showing that the previous determinations were fairly accurate.  
During the second series of experiments the following values of H were obtained by the coil method:—

Date.	Current ampere.	Distance of coil from mirror.	Mean Deflection.	Tan. θ	H.	Mean value of H.
Aug. 23 ... ..	·48	mm. 1,000	mm. 20·09	·010045	·1269	1·280
„ 23 ... ..	·47	750	44·37	·022185	·1297	
„ 24 ... ..	·455	„	42·70	·021350	·1269	
„ 24 ... ..	·44	„	41·86	·02093	·1287	

Taking the strongest magnets of each group in the second series of experiments, and arranging them in order, we have—

	Induction.
Marchal, No. 1 ... ..	2,835
Clemandot, No. 1 ... ..	2,362
"Allevard," No. 3 (water tempered) ... ..	1,879
Ashforth, No. 4 ... ..	1,779
Jowitt, No. 2 ... ..	1,745
Wall, No. 4 ... ..	1,689
Saunderson, No. 1 ... ..	1,610
"Allevard," No. 2 (mercury tempered) ... ..	1,528
Crewe "spring," No. 1 ... ..	1,436
Vickers, No. 2 ... ..	1,297
Crewe "rivet," No. 3 ... ..	217

TABLE II.

RESULTS OF EXPERIMENTS FOR DETERMINING THE MAGNETIC MOMENTS, &c., OF VARIOUS KINDS OF STEEL.

Second Series.—August, 1890.

Name of manufacturer.	No. of Specimen.	Weight.	Mean area of pole.	Length.	Volume.	Mean moment.	Specific Magnetism.	Intensity of magnetisation (I).	Induction (4 $\pi$ I) H.	Mean Induction of specimens made from each kind of steel.	Remarks.
		Grammes.	Sq. c.m.	c.m.	cub. cm.						
Wall ... ..	1	67·279	·8503	10·025	8·525	1003·5	14·91	117·7	1479	1519	
	2	67·235	·8513	10·04	8·547	946·4	14·08	110·7	1391		
	3	66·252	·8446	10·02	8·463	1022	15·42	120·7	1517		
	4	66·648	·8487	10·01	8·496	1142	17·13	134·4	1689		
Ashforth ... ..	1	75·228	·9295	10·00	9·295	1258	16·72	135·3	1700	1704	
	2	76·265	·9436	10·00	9·436	1264	16·57	133·9	1682		
	3	75·870	·9365	10·00	9·365	1103	14·54	131·9	1657		
	4	76·247	·9398	10·03	9·426	1334·5	17·50	141·6	1779		
Saunderson ... ..	1	77·962	·9712	10·04	9·750	1249	16·02	128·1	1610	1435	
	2	77·800	·9740	10·03	9·770	1054	13·55	107·9	1356		
	3	76·955	·9645	10·03	9·674	1036	13·46	107·1	1346		
	4	77·145	·9634	10·03	9·662	1099	14·24	113·7	1429		
Jowitt ... ..	1	73·928	·9186	10·04	9·222	968	13·09	104·9	1319	1503	
	2	74·120	·9249	10·03	9·276	1288	17·35	138·8	1745		
	3	72·058	·8995	10·03	9·022	998	13·85	110·6	1390		
	4	73·840	·9214	10·03	9·241	1147	15·53	124·1	1560		
Vickers ... ..	1	68·630	·8811	10·04	8·846	815	11·88	92·12	1158	1174	
	2	70·043	·9010	10·03	9·037	933	13·32	103·2	1297		
	3	66·651	·8589	10·02	8·606	730	10·45	84·82	1066		
(Crewe "rivet steel")	1	75·751	·9731	9·98	9·711	157	2·072	16·16	203	186·6	
	2	75·820	·9790	9·97	9·760	151	1·991	15·47	194		
	3	75·553	·9736	9·97	9·706	167·5	2·217	17·26	217		
	4	77·210	·9909	10·00	9·909	104·5	1·353	10·84	132·5		
Crewe "spring steel"	1	75·012	·9763	10·02	9·783	1118·5	14·91	114·3	1436	1391	
	2	76·086	·9837	10·02	9·857	1056	13·88	107·1	1346		
Clemandot ... ..	A1	79·518	—	9·90	9·914	1864	23·44	188·0	2362	2265	Mean induction increased by 103 per cent. over its original value by remagnetisation in our coil.
	2	80·335	—	9·95	10·04	1797·5	22·37	179·0	2250		
	3	80·208	—	9·98	10·03	1783	22·22	177·8	2234		
	4	79·94	—	9·96	9·993	1786	22·34	178·7	2245		
	5	80·542	—	9·97	10·07	1738	21·58	172·6	2169		
	6	79·958	—	9·96	9·995	1853	23·17	185·4	2329		
	B7	80·322	—	9·88	10·04	1065	13·26	106·1	1333		
Marchal ... ..	1	78·478	·9917	10·00	9·917	1671·5	21·30	168·5	2118	1758	Before re-magnetisation.
	2	80·253	1·011	10·00	10·106	1495	18·63	148·0	1859		
	3	79·380	1·014	10·00	10·136	1304	16·43	128·6	1616		
	4	79·540	1·001	10·00	10·01	1565	19·68	156·3	1964		
	5	78·260	·9992	10·00	9·992	1135	14·50	113·6	1427		
	6	79·488	1·0006	10·00	10·006	1246	15·68	124·5	1565		
Marchal ... ..	1	78·478	·9917	10·00	9·917	2237	28·50	225·6	2835	2540	After remagnetisation. Mean induction increased by 38 per cent. over its original value.
	2	80·253	1·011	10·00	10·106	2231	27·67	219·8	2761		
	3	79·380	1·014	10·00	10·136	1842	23·20	181·7	2283		
	4	79·540	1·001	10·00	10·01	2147	26·99	214·5	2695		
	5	78·260	·9992	10·00	9·992	1845	23·57	184·6	2320		
	6	79·488	1·0006	10·00	10·006	1868	23·50	186·7	2346		
"Allevard" ... ..	1	79·900	·9994	9·86	9·856	865	10·83	87·76	1103	1315	
	2	80·415	1·0064	9·87	9·934	1208	15·02	121·6	1528		
	3	79·600	·9944	9·89	9·835	1471	18·48	149·5	1879		
	4	79·765	1·0054	9·90	9·954	1142	14·31	114·7	1442		

If we take the mean induction of the magnets of each group, which is probably a fairer method of comparison, we obtain a slightly different order, viz.:

	Mean Induction.
Marchal ... ..	2,540
Clemandot ... ..	2,265
Ashforth ... ..	1,704
Allevard (water tempered) ... ..	1,660
Wall ... ..	1,519
Jowitt ... ..	1,503
Saunderson ... ..	1,435
Crewe "spring" ... ..	1,391
Allevard (mercury tempered) ... ..	1,315
Vickers ... ..	1,174
Crewe "rivet" ... ..	186·6

The marked superiority of the Marchal magnets over those made of English steel is evidently not due to the method of magnetisation adopted by the maker, since their mean induction was increased by 38 per cent., and their magnetisation rendered more uniform by re-magnetisation in our coil. Their greater strength must therefore be due either to the quality of the steel, or to the

mode of tempering—most probably the latter. The Clemandot compressed steel magnets, too, which were very poor when first tested, had their mean induction more than doubled by re-magnetisation.

In view of the results of these experiments, I purpose to investigate further the methods of tempering magnet steel. It is pretty clear there is room for improvement in our present practice.

I am indebted to M. Trotin, of the French Telegraphic Administration, for having kindly procured the French specimens for me.

The induction in these short straight bars is comparatively low, because we measure only the lines (Maxwell's B) that radiate from the ends. Prof. Perry has succeeded in getting as much as 12,700, with Jowitt steel, through the middle of a magnet of a special horseshoe form. It ought, apparently, to be possible to get about 20,000 with the best French steel.

I happen to have in my possession two small horseshoe magnets of Allevard steel which were made for Mr. H. Edmunds, and magnetised in Paris in 1881. The induction of one is now 3,287·3, and of the other 3,552·5. They have never been touched since 1881. The retentiveness is therefore very good.

All these measurements have been made with great patience and skill by Mr. Henry Hartnell.

## ON ANTI-EFFECTIVE COPPER IN PARALLEL CONDUCTORS OR IN COILED CONDUCTORS FOR ALTERNATE CURRENTS.

By Sir WM. THOMSON.

(Read Before Section A, September 5th, 1890.)

1. It is known that by making the conductors of a circuit too thick, we do not get the advantage of the whole conductivity of the metal—copper, let us say—for alternate currents. When the conductor is too thick, we have in part of it comparatively ineffective copper present; but, so far as I know, it has generally been supposed that, the thicker the conductor, the greater will be its whole effective conductance, and that thickening it too much can never do worse than add comparatively ineffective copper to that which is most effective in conveying the current. It might, however, be expected that we could get a positive augmentation of the effective ohmic resistance, because we know that the presence of copper in the neighbourhood of a circuit carrying alternate currents, causes a virtual increase of the apparent ohmic resistance of the circuit, in virtue of the heat generated by the currents induced in it. May it not be that, anti-effective influence, such as is thus produced by copper not forming part of the circuit, can be produced by copper actually in the circuit if the conductor be too thick? Examining the question mathematically, I find that it must be answered in the affirmative, and that great augmentation of the effective ohmic resistance is actually produced if the conductor be too thick; especially in coils consisting of several layers of wire laid over one another in series around a cylindric or flat core (as in various forms of transformers).

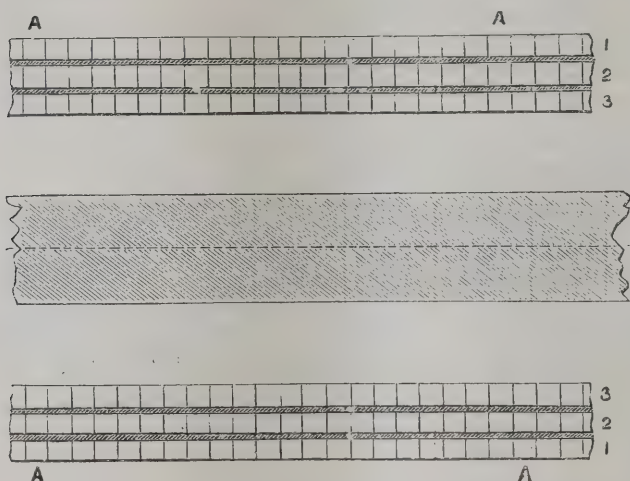


FIG. 1.

2. Fig. 1 may be imagined to represent the secondary coil of a transformer consisting of solid square copper wire in three layers. For simplicity, we suppose the axial length to be infinitely great, and straight; but the uniformity which this involves, and a close practical application to its simplicity is realised in that excellent form of transformer which consists of a toroidal iron core completely covered by primary and secondary wires laid on toroidal surfaces. To simplify the mathematical work, I suppose the whole thickness of the three layers to be small in comparison with the greatest radius of curvature of the circular or flat cylindric surface on which the wire is wound, but if it is not so the solution is easily obtained, for the case of circular cylinders, in terms of the Fourier-Bessel functions. It is of no consequence for our present question what there be inside of coil No. 3, and if we please we may imagine there to be nothing but air; the drawing, however, indicates an iron core and space which might be occupied by the primary coil, if a transformer is the subject; or our coil, A, A, A, A, may be the primary coil of a transformer with secondary coil and core inside it, and the alternate current maintained in it by an external electromotive agent acting in an arc between its ends outside. Our present results are applicable to all these varieties of cases indifferently, all that is essential being that the total quantity of current be given at each instant, and be uniform throughout the whole length of the coiled conductor.

3. This last condition is secured by perfectness of insulation between all contiguous turns of the coil, unless we were considering so enormously long a coil that the quantity of electricity required for the essential changes of static electrification would be sensible as constituting drafts from, or contributions to, the current in the coil. The consideration of static electrification involved in the maintenance of alternate currents through a coil such as that represented in fig. 1, is exceedingly curious and interesting; but we do not enter on it at present at all, as in all practical cases the quantities concerned are quite infinitesimal in comparison with the whole quantity flowing in one direction or the other in the half period.

4. In the drawing, the section of the wires is represented as square, but this is not essential, and in practice a flat rectangular

ribbon would, no doubt, for some dimensions of coils, be preferable. I assume the thickness of the insulation between the successive squares or rectangles in each layer to be infinitely small in comparison with the breadth of the rectangle; but the thickness of the insulation between successive layers, which is a matter of indifference to my calculations, may be anything, and would in practice naturally be, as shown in the diagram, considerably greater than the thickness of the insulation between the contiguous portions of the coil in each layer.

5. The full mathematical work which I hope to communicate to the *Philosophical Magazine* for publication in an early number, includes an investigation of the self-induction of the coil, with or without anything in its interior (such as core, or primary wire of a transformer), but, at present, I merely give results so far as effective ohmic resistance, or generation of heat in the interior of the wire of the coil, A, A, A, A, itself is concerned; which, as said above, is independent of everything in the interior, and of the mode in which the alternating current is produced, provided only that the total amount of electricity crossing the section of the wire per unit of time be given at each instant.

6. As a preliminary to facilitate the expression of these results, it is convenient first to give a general statement of the solution of the problem of laminar diffusion of a simple harmonic variation, applied to the case of electric currents in a homogeneous conductor. Let the periodically varying magnetic force in the air or other insulating material in the neighbourhood of so small a portion,  $s$ , of the surface of a conductor that we may regard it as plane be given. Resolve this magnetic force into two components, one perpendicular to  $s$  which we may neglect, as it has no influence in connection with the currents we are to consider; the other parallel to  $s$ , which we shall call the effective component, and denote by  $\gamma$ . Through any point,  $o$ , of  $s$ , draw three rectangular lines,  $ox$ ,  $oy$ ,  $oz$ , of which  $oy$  and  $oz$  are in  $s$ , and  $ox$  is parallel to the direction of the directive magnetic force component,  $\gamma$ . Let now the value of  $\gamma$  at time,  $t$ , be

$$\gamma = M \cos \frac{2\pi t}{T},$$

where  $M$  denotes a constant, and  $T$  the period of the alternation. The varying magnetic force,  $z$ , to whatever cause it may be due, gives rise to currents parallel of  $oz$  in the conductor, expressed by the following formula for  $\gamma$ , the current intensity at distance,  $x$ , from the plane,  $s$ , provided  $x$  be small enough to fulfil the condition stated below:—

$$\gamma = \frac{M}{\lambda \sqrt{2}} e^{-\frac{2\pi x}{\lambda}} \cos \left( \frac{2\pi t}{T} - \frac{2\pi x}{\lambda} + \frac{1}{2}\pi \right),$$

where  $\lambda$  denotes what we may call the wave length of the disturbance and is given in the terms of  $T$ , the period of the disturbance, and  $\rho$  and  $\omega$  the resistivity and magnetic permeability of the substance, by the following formula:—

$$\lambda = \sqrt{\frac{T\rho}{\omega}}.$$

For copper we have  $\omega = 1$ , and  $\rho = 1611$  square centimetres per second; and thus for 80 periods per second  $\lambda = 4.49$  or, say,  $4\frac{1}{2}$  centimetres.

In order that the formula for  $\gamma$  may be approximately true, it is necessary, in the first place, that  $\lambda$  must be small in comparison with the distance we must travel in any direction in the surface of  $s$ , before finding any deviation of it from the tangent plane through  $o$ , comparable with  $\lambda$ . Secondly, for a very good approximation,  $\lambda$  must be so small that we may be able to travel inwards, in any direction from  $o$ , through a space equal to at least twice  $\lambda$ , without coming to any other part of the bounding surface of the conductor. If, for example, the surface be a flat plate, this condition requires that the thickness be more than twice  $\lambda$ . But (because  $e^{-\pi}$  is less than  $1/23$ ), the formula gives a very fair approximation, requiring for a half the thickness of the plate inwards from  $s$  no greater correction than about 4 per cent, even if the thickness of our plate be no greater than  $\lambda$ . When the thickness of the plate is less than  $2\lambda$ , we may consider waves of electric current as travelling inwards from its two sides and being both sensible at the middle of the plate; and a complete solution of the problem is readily found by the method of images. But, a direct analytical investigation, by which the proper conditions of relation to varying magnetic force on the two sides of the plate are fulfilled is the most convenient way of fully solving the problem, and it is thus that the results given below have been obtained.

7. The smallness of the insulating space between the successive turns in each layer of our coil A, A, A, A, and the equality of the whole current through them all, prevent any surface disturbance from being produced at the contiguous faces, and allow the problem to be treated as if, instead of a row of squares or rectangles we had a continuous plate forming each stratum. The smallness of the thickness of this plate in comparison with the radius of the cylindric surface to which it is bent, allows, as said above, the mathematical treatment for an infinite plate bounded by two parallel planes to be used without practical error. I have thus found an expression for the intensity of the current at any point in the metal of any one of the layers of a coil of one, two, three, or more layers; and have deduced from it an expression for the quantity of heat generated per unit of time, at any instant, per unit breadth in any one of the layers. I need not at present quote the former expression; the latter is as follows. With  $q$  to denote

the dynamical value in time average of the heat generated, per unit of time at different instants of the period, per unit breadth and unit length in layer No.  $i$  from the outside of the coil,  $c^2$  the time average of the square of the total current per unit breadth, and  $a$  the thickness of the layer

$$q = \frac{2 \pi \rho}{\lambda} \rho \Theta c^2$$

where  $\Theta = \frac{\epsilon^2 \theta + 2 \sin 2 \theta - \epsilon^{-2 \theta}}{\epsilon^2 \theta - 2 \cos 2 \theta + \epsilon^{-2 \theta}} + 2 i(i-1) \frac{\epsilon^{\theta} - 2 \sin \theta - \epsilon^{-\theta}}{\epsilon^{\theta} + 2 \cos \theta + \epsilon^{-\theta}}$

and  $\theta = \frac{2 \pi a}{\lambda}$ .

8. The numerical results shown in the table have been calculated, and the accompanying graphic representation (fig. 2), drawn, for me by Mr. Magnus Maclean.

TABLE OF VALUES OF  $\theta$ .

$\frac{16 \theta}{\pi}$	$i = 1$	$i = 2$	$i = 3$	$i = 4$
1	5.113	5.118	5.127	5.141
2	2.553	2.592	2.669	2.786
4	1.316	1.634	2.270	3.224
6	.9854	1.997	4.019	7.053
8	.9173	2.993	7.143	13.37
10	.9452	4.062	10.30	19.65
12	.9822	4.899	12.73	24.48
14	1.000	5.276	13.83	26.66
16	1.002	5.362	14.08	27.16
$\infty$	—	5.00	13.00	25.00

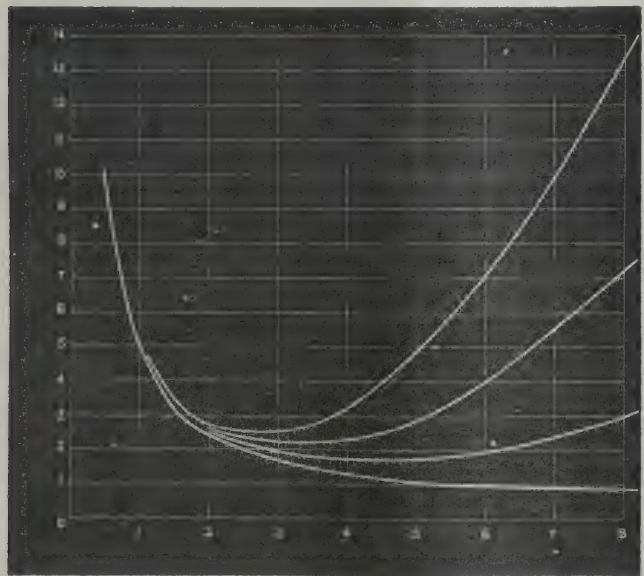


FIG. 2.

8. We see from the table and curves that each curve has a minimum distance from the line of abscissas, and that each comes to a horizontal asymptote, parallel to the line of abscissas, for  $\theta = \infty$ . By looking at the formula, we see that there is, in fact, an infinite succession of minimums and maximums in the expression for  $\Theta$ , but it is only the first minimum, and the following maximum, that occur within the range of variation of  $\theta$ , which we regard as sensible. In the case of  $i = 1$ , the formula gives  $\theta = \frac{1}{2} \pi$  for the first minimum. The curves show for the case of  $i = 2, 3, 4$ , respectively, the first minimum at  $\frac{16 \theta}{\pi} = 4\frac{1}{2}, 3$ , and  $2\frac{6}{10}$ , respectively. The thickness which corresponds to  $\theta = \pi$  is the half wave length of the electric disturbance, which, as we have seen is for copper 2.244 centimetres, when the frequency of the alternations is 80 periods per second; and for this case, therefore, the thicknesses that give minimum generation of heat in the first, second, third, and fourth layers are, respectively, 11.22, 6.31, 4.21, and 3.65 millimetres. Anything more of continuous copper than these thicknesses in any of the layers would be not merely ineffective or comparatively ineffective, but would be positively anti-effective. Even with so small a thickness as 2.8 millimetres, for copper and frequency 80, line 2 of the table (corresponding to a sixteenth of the wave-length) shows, in the first, second, third, and fourth layers, losses of 0.3 per cent., 2 per cent., 5 per cent., and 10 per cent. in excess of that due to the true ohmic resistance of the copper, were it all effective. When the size chosen for the transformer and the amount of output required of it are such that a thickness of  $2\frac{1}{2}$  millimetres in the direction perpendicular to the

layers is insufficient, a remedy is to be had by using braided wire, or twisted strand, with slight insulation of varnish or whitewash, crushed or rolled into rectangular or square form of the desired thickness and breadth. A very slight resistance between the different wires thus crushed together would suffice to cause the current to run nearly enough full bore to do away with any sensible loss from the cause which forms the subject of this communication.

ON THE FORM OF SUBMARINE CABLES FOR LONG  
DISTANCE TELEPHONY.

By W. H. PREECE, F.R.S.

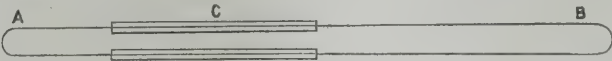
(Read before Section G, September 9th, 1890.)

At the Newcastle meeting last year, I gave the reasons and experiments which led to the conclusion that telephoning between London and Paris was practical. New and distinct aerial lines of four copper wires are now being erected by the respective governments from each capital to the coast, and a new cable, the joint property of the two governments, will be laid during this year, between the Kent coast and Sangatte, to connect these two lines. There will thus be two metallic circuits between the two capitals. The  $\kappa \epsilon$ , that is the product of the capacity,  $\kappa$ , and the resistance,  $\epsilon$ , of each circuit, upon which the clearness of articulation depends, will be 5,900, indicating that speech should be excellent.

A somewhat similar circuit has been established, since October last, between Buenos Ayres and Monte Video, under my advice. The cables across the La Plata are each 28 miles long, for there are two separate single wire cables, and the total distance between the two cities is 180 miles. Subscribers, who have metallic circuits in each city, have no difficulty whatever in speaking to each other from their respective offices, although the  $\kappa \epsilon$  is as high as 10,400.

The cable across the Channel will be a four-wire cable, and the specification for its construction has been based on the following mathematical development by Mr. H. E. Kempe.

Let there be a looped telephonic line between A and B, with a cable c, at an intermediate point on the route.



The working capacity of the whole line is dependent upon the product of the total resistance,  $\epsilon$ , and the total capacity  $\kappa$ . Therefore, if we take the resistance of the aerial portion of the line to be a fixed quantity, there will be a particular size of cable conductor which will give the smallest possible size of dielectric, sufficient to enable a particular value of  $\kappa \epsilon$  not to be exceeded. For, if we make the conductor larger than this size, and thereby diminish its resistance, we can, it is true, do with an increased capacity, but the diminution in the thickness of the dielectric which could thereby be allowed, is more than compensated for by the fact that the surface of the conductor is larger; in other words, we increase the capacity in a greater proportion than we diminish the resistance. If, on the other hand, we diminish the size of the conductor, we increase the resistance in a greater proportion than we diminish the capacity. Strictly speaking, the requirements of the problem are to determine the size of cable core which shall cost least; but inasmuch as the costs of gutta-percha and copper, bulk for bulk, do not differ greatly, the problem resolves itself into the determination of the smallest outer diameter which can be employed.

Let

$r$  = total resistance of aerial line,  
 $\rho$  = " " " cable,  
 $k$  = " capacity of aerial line,  
 $\kappa$  = " " " cable.

Then

$\kappa \epsilon = (k + \kappa) (r + \rho).$

Let

$D$  = diameter of dielectric of cable,  
 $x$  = " " conductor " "

Then

$\rho = \frac{a}{x^2}$  and  $\kappa = \frac{b}{\log_{\epsilon} \frac{D}{x}}$

where  $a$  and  $b$  are constants.

We have, therefore,

$\kappa \epsilon = \left( k + \frac{b}{\log_{\epsilon} \frac{D}{x}} \right) \left( r + \frac{a}{x^2} \right)$

therefore

$\log_{\epsilon} \frac{D}{x} = \frac{\kappa \epsilon}{r + \frac{a}{x^2}} - k = \frac{\kappa \epsilon - k \left( r + \frac{a}{x^2} \right)}{r + \frac{a}{x^2}}$

therefore

$\log_{\epsilon} \frac{D}{x} = \frac{b \left( r + \frac{a}{x^2} \right)}{\kappa \epsilon - k \left( r + \frac{a}{x^2} \right)}$

therefore

$$\log_{\epsilon} D = \frac{b \left( r + \frac{a}{x^2} \right)}{KR - k \left( r + \frac{a}{x^2} \right)} + \log_{\epsilon} x$$

$$= \frac{r + \frac{a}{x^2}}{\frac{KR - k r}{b} - \frac{k a}{b x^2}} + \log_{\epsilon} x = \frac{\frac{r}{a} + \frac{1}{x^2}}{\frac{KR - k r}{a b} - \frac{k}{b x^2}} + \log_{\epsilon} x$$

$$= \frac{A + \frac{1}{x^2}}{B - \frac{C}{x^2}} + \log_{\epsilon} x = u, \text{ say}$$

where

$$A = \frac{r}{a}$$

$$B = \frac{KR - k r}{a b}$$

$$C = \frac{k}{b}$$

Now to make  $D$  a minimum we must make  $\log_{\epsilon} D$  (that is  $u$ ) a minimum, and this we have to do by variation of  $x$ , therefore we have

$$\frac{d u}{d x} = \frac{1}{\left( B - \frac{C}{x^2} \right)^2} \left\{ \left( B - \frac{C}{x^2} \right) \frac{2}{x^3} - \left( A + \frac{1}{x^2} \right) \frac{2 C}{x^3} \right\} + \frac{1}{x} = 0$$

therefore

$$\frac{1}{x} = \frac{1}{\left( B - \frac{C}{x^2} \right)^2} \left\{ \left( B - \frac{C}{x^2} \right) \frac{2}{x^3} + \left( A + \frac{1}{x^2} \right) \frac{2 C}{x^3} \right\}$$

$$= \frac{2}{x^3 \left( B - \frac{C}{x^2} \right)^2} \left\{ \left( B - \frac{C}{x^2} \right) + \left( A + \frac{1}{x^2} \right) C \right\}$$

$$= \frac{2}{x^3 \left( B - \frac{C}{x^2} \right)^2} \{ B + A C \}$$

therefore

$$x^2 \left( B - \frac{C}{x^2} \right)^2 = 2 \{ B + A C \}$$

therefore

$$x \left( B - \frac{C}{x^2} \right) = \sqrt{2 \{ B + A C \}}$$

therefore

$$B x - \frac{C}{x} = \sqrt{2 \{ B + A C \}}$$

therefore

$$x^2 - \frac{x \sqrt{2 \{ B + A C \}}}{B} = \frac{C}{B}$$

From which, by solving the quadratic equation, we get

$$x = \frac{\sqrt{B + A C} + \sqrt{B + A C + 2 B C}}{\sqrt{2 B}}$$

Now, careful experiments made on an aerial line of copper wire, weighing 200 lbs. per mile (diameter = 112 mils.), the wire being 30 feet above the ground showed that the inductive capacity per mile was .015 microfarads very nearly, consequently the capacity per mile is expressed by the formula

$$\frac{.061637}{6.1583625 - \log d}$$

$d$  being the diameter of the wire in mils.

From this formula the capacity per mile of a wire weighing 400 lbs. works out .0156 m.f. The average resistance per mile of a wire of this weight is 2.25 ohms.

Taking the distance between London and Dover to be 70 miles, and between Calais and Paris to be 180 miles, the total distance of the loop will be 500 miles, which for a 400 lbs. copper wire gives the resistance

$$r = 500 \times 2.25 = 1,125 \text{ ohms.}$$

Now, in the case of a looped wire, the total capacity equals half that of a single wire, hence

$$k = \frac{.0156 \times 250}{2} = 1.95.$$

Assuming the length of the cable to be 21 knots, we have approximately

$$\rho = \frac{42 \times 74,402}{x^2} \text{ for copper of 98 per cent. conductivity at } 60^\circ \text{ F.}$$

so that

$$a = 3,124,884.$$

The ordinary standard core used by the Post Office has a con-

ductor diameter of 86.41 mils., and a gutta-percha diameter of 285 mils., and a capacity of 1/3 m.f. per knot, and as

$$\text{capacity per knot} = \frac{\text{const.}}{\log \frac{D}{d}}$$

we have

$$1/3 = \frac{\text{const.}}{\log \frac{285}{82.087}}$$

or

$$\text{const.} = \frac{\log \frac{285}{82.087}}{3} = .18018997$$

The capacity of 42 knots of looped cable will be half that of 21 knots of single cable, hence

$$K = \frac{.18018997 \times \frac{21}{2}}{\log \frac{D}{a}} = \frac{1.8919947}{\log \frac{D}{a}}$$

$$= \frac{4.356481}{\log_{\epsilon} \frac{D}{x}}$$

so that

$$b = 4.356481$$

We have then for 400 lbs. wire

$$a = 3,124,884$$

$$b = 4.356481$$

$$r = 1,125$$

$$k = 1.95$$

If we take  $KR = 7,500$ , which is the highest value that can safely be taken, we get

$$B = \frac{7,500 - 1.95 \times 1,125}{3,124,884 \times 4.356481} = .000389779$$

$$2 B C = \frac{2 \times .000389779 \times 1.95}{4.356481} = .000348937$$

$$\sqrt{2 B} = .000551231$$

$$A C = \frac{1.95 \times 1,125}{3,124,884 \times 4.356481} = .0001611454$$

From this we get

$$\sqrt{B + A C} = .02347177$$

$$\sqrt{B + A C + 2 B C} = .0299977$$

$$\sqrt{2 B} = .000551231$$

$$\text{so that } x = \frac{.02347177 + .0299977}{.000551231} = 97.00014$$

$$\text{and extreme diameter of strand} = 97.00014 \times \frac{100}{95} = 102.1054 \text{ mils.}$$

Since  $KR = (k + \kappa) (r + \rho)$

we get

$$\kappa = \frac{KR}{r + \rho} - k$$

$$= \frac{7,500}{1,125 + \frac{3,124,884}{(97.00014)^2}} - 1.95 = 3.197153$$

But

$$\kappa = \frac{1.89199468}{\log \frac{D}{x}}$$

therefore

$$\log D = \frac{1.89199468}{\kappa} + \log x = \frac{1.89199468}{3.197153} + 1.9867724$$

$$= 2.5785475 = \log \text{ of } 378.86$$

$$= 380 \text{ mils approximately.}$$

If we take

$$x = 95 \quad \text{then } D = 378.94$$

$$,, \quad 97.00014 \quad ,, \quad 378.86$$

$$,, \quad 99 \quad ,, \quad 379.08$$

which proves the correctness of the calculation for a minimum.

The values of these diameters correspond very closely to a core, the weight of whose conductor is 160 lbs., and the weight of whose gutta-percha covering is 300 lbs., and it has therefore been decided to adopt those dimensions.

Although the calculation has been made on the assumption that the land lines on both sides of the cable are to be of 400 lbs. wire, the French Government have decided that the wires to be erected by them shall be of 600 lbs. weight; the result of this will be to reduce the value of  $KR$  to 5,900, as stated at the commencement of the paper.

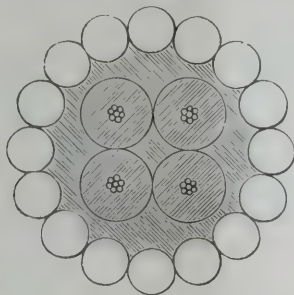
The specification of the cable states that:—(1) Each conductor shall be formed of a strand of seven copper wires all of equal diameter, shall weigh 160 lbs. per nautical mile, and shall at a temperature of  $75^\circ$  Fahrenheit have a resistance not higher than 7.632 ohms or lower than 7.478 ohms per nautical mile.

(2) Each conductor shall be insulated by being covered with

three alternate layers of Chatterton's compound and gutta-percha, beginning with a layer of the said compound, and no more compound shall be used than may be necessary to secure adhesion between the conductor and the layers of gutta-percha. The dielectric on each conductor shall weigh 300 lbs. per nautical mile, making the total weight of each conductor when covered with the dielectric 460 lbs. per nautical mile.

(3) The inductive capacity of such insulated conductor shall not exceed '3045 microfarad per nautical mile.

(4) The insulation resistance of each coil of core shall be not less than 500 megohms per nautical mile after such coil shall have been kept in water maintained at a temperature of 75° Fahrenheit for not less than 24 consecutive hours immediately preceding the test, and after electrification during one minute.



The cores (four in number) are to be served with the best wet fully tanned yarn, and with a sheathing of 16—280 mil. wires, each having a minimum breaking strain of 3,500 lbs., and a minimum of 10 twists in 6 inches. The section of the cable is shown by the fig.

#### SUGGESTIONS TOWARDS A DETERMINATION OF THE OHM.

By Prof. J. V. JONES, Principal and Professor of Physics in the University College of South Wales and Monmouthshire, Cardiff.

(Read in conjunction with the Discussion on Electrical Units, in Section A, September 5th, 1890.)

"ON the whole I am of opinion that if it is desirable at the present time to construct apparatus on the most favourable scale so as to reach the highest attainable accuracy, the modification of Lorenz's method, last described, is the one that offers the best prospect of success. Before this is done, however, it appears to me important that the value now three times obtained in the Cavendish Laboratory, by distinct methods, should be approximately verified (or disproved) by other physicists. To distinguish between this value and those obtained for instance by Kohlrausch, by Lorenz, or by the first B. A. Committee, should not require the construction of unusually costly apparatus. Until the larger question is disposed of, it seems premature to discuss the details of arrangements from which the highest degree of precision is to be expected."

The above passage which concludes a paper communicated by Lord Rayleigh to the *Philosophical Magazine*, in November, 1882, nearly two years before the Electrical Congress at Paris, at which the legal ohm was defined to be the resistance of a column of mercury of 1 sq. mm. section and 1,060 mm. long, seems not to have met with adequate response in this country. So far as published experiments in English laboratories are concerned, the determination of the ohm remains where Lord Rayleigh left it, except for the contribution made by Glazebrook and Fitzpatrick in their measurement of the specific resistance of mercury in terms of the B.A. unit, which is one of the elements in the determination of the specific resistance of mercury in absolute measure by Lord Rayleigh's adaptation of Lorenz's method.

But though in England the scientific world has during the last seven or eight years occupied itself with other things, in other countries, and more especially in America and France, measurements have been made which have confirmed the Cavendish Laboratory result as against the other values mentioned by Lord Rayleigh in the passage quoted. Further, indication has already been given of the intention to employ as the unit of electrical resistance in the new Government Standardising Laboratory not the so-called legal ohm but the true ohm as nearly as it can be determined, and Major Cardew in the paper recently read by him before the Institution of Electrical Engineers has invoked the assistance of Lord Rayleigh and the British Association Electrical Standards Committee in the preparation of the required unit. The work judged necessary by Lord Rayleigh before the conditions of a more accurate determination could be advantageously discussed having been done; and practical necessity for an authoritative determination having arisen in connection with the standardising laboratory, the time seems ripe for a consideration of arrangements likely to secure high accuracy, and it is with this view that I venture to bring before the section the suggestions embodied in this paper.

In the hope of paving the way for a more accurate determination (and initially moved to the work by the invitation given in the passage which I first read) I have for a considerable time been engaged in submitting to the test of experiment certain modifications of the method of Lorenz which occurred to me as likely to lead to increased accuracy and certainty. I do not propose to

trouble the section with the details of these experiments, which I hope may be published elsewhere. I mention them merely to give the suggestions brought forward the support derived from a determination actually made on the lines indicated. The experiments have been made in the laboratory of the University College at Cardiff with apparatus for the most part constructed in the college workshop. Five complete sets of observations were taken in the spring of this year with the following results for the specific resistance of mercury at 0° C. :—

(i.)	94,103	absolute units
(ii.)	94,074	" "
(iii.)	94,093	" "
(iv.)	94,045	" "
(v.)	94,021	" "

Mean 94,067 ± 10 (probable error). The result may be otherwise expressed by saying that the ohm is equal to the resistance of a column of mercury of 1 square mm. sectional area, and 106·307 centimetres long, the probable error being ± 0·012.

It is far from my intention to bring these numbers forward as the best determination possible by the method I have used. I do not think they at all represent the accuracy attainable if the apparatus were to be constructed on a scale a little larger, and with a certain perfecting of detail. Undersuch circumstances I am of opinion that a single set of observations will give a result accurate to one part in ten thousand, and that as a mean of a number of observations we may, perhaps, aim at the hundred-thousandth if regard is paid to the maintenance of definite temperatures in all parts of the apparatus, and if we can be said to know our length standards to this degree of accuracy.

In Lorenz's method a metallic disc is made to rotate in the mean plane of a coaxial standard coil. Wires touching the centre and circumference of the disc are led to the ends of the resistance to be measured, and the same current is passed through this resistance and the standard coil. The connections being rightly made we may, by varying either the rate of rotation of the disc or the resistance to be measured, so arrange matters as to have no change of current in the circuit of the disc and wires joining it to the ends of the resistance when the direction of the current through the resistance and the standard coil is changed. When this arrangement is effected there is a balance between the electromotive force due to the motion of the disc in the magnetic field of the current in the standard coil, and the difference of potential at the ends of the resistance due to the current traversing it. If this adjustment is made, let us say that the apparatus is in an equilibrium position.

If  $M$  = the coefficient of mutual induction of the standard coil and the circumference of the disc;

$n$  = the rate of rotation of the disc (number of revolutions per second);

$R$  = the resistance;

$\gamma$  = the current through the standard coil and resistance;

then, in an equilibrium position,

$$M n \gamma = R \gamma$$

or

$$M n = R.$$

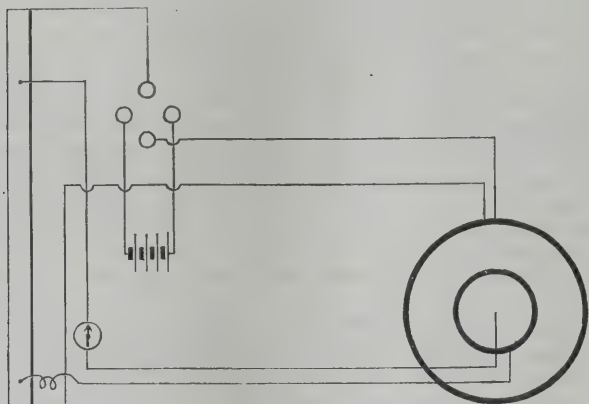
In practice it is not possible to take the coefficient of mutual induction and the rate of rotation large enough to make the measured resistance more than a small fraction of an ohm\*; and this has usually been regarded as one of the difficulties of Lorenz's method.

In order that the absolute unit may be recoverable at pleasure without the fatigues of a new absolute determination, it must be defined in practice by reference to the specific resistance of some standard substance, and for many reasons there is a consensus of opinion in making this standard substance mercury. The determination of the ohm as a practical problem, therefore, becomes identical with the determination of the specific resistance of mercury in absolute measure, and the small resistance measured by the method of Lorenz's must, in order to complete the investigation, be brought into relation and compared with the specific resistance of mercury. Lorenz himself evaded the difficulty by taking for his measured resistance the resistance of a mercury column contained in a glass tube; the resistance of the column was then obtained in absolute measure, and the specific resistance calculated from the dimensions of the column. It is hardly possible, however, that the latter calculation can have been, or is likely to be, achieved with accuracy, however accurately the tube be calibrated. For, on the one hand, if the wires from the disc (the terminal portions of which may be called the electrodes) are led to the ends of the tube, the equipotential surfaces touched by them are not plane; and, on the other, if they are let into the tube at some distance from the ends, it is difficult to see how the distance between them is to be measured with the requisite accuracy.

Under these circumstances Lord Rayleigh preferred to use solid conductors, overcoming the difficulty of comparing the resistance measured with ordinary standards by a shunt method, which made it possible to express it at once in terms of the B.A. unit. The B.A. unit being thus found in absolute measure, a separate investigation of the specific resistance of mercury in terms of the B.A. unit completed the determination. Rowland and others have adopted the shunt method of Lord Rayleigh, which may be said to be an essential feature in the more probable determinations

\* Lorenz '0008    ...    '002.  
Rayleigh '002    ...    '004

by Lorenz's method. Spite of the conspicuous success which has attended the use of solid conductors by the shunt method, I venture to suggest a reversion to Lorenz's use of mercury. The physical constant to be measured is the specific resistance of mercury, and if this can, by direct measurement, be determined with accuracy, it seems inconvenient and undesirable first to determine the resistance of the B.A. unit in absolute measure, and then to determine the specific resistance of mercury in B.A. units. If consistently with accuracy the artificial B.A. unit can be dropped out of our experiments as well as out of the result; and the measurements made directly on mercury, the simplicity would seem to be a recommendation, and the argument is perhaps enforced by the consideration that there is very nearly as much divergence in the results of different observers for the specific resistance of mercury in B.A. units as there is in the values obtained for the B.A. unit in absolute measure.



The objections to the use of mercury in a tube are unanswerable; but the difficulties disappear if instead of placing the mercury in a tube, it is placed in a long trough, and if instead of measuring the distance between the two electrodes, one electrode is kept fixed while measurement is made of the distance moved through by the other between two equilibrium positions corresponding to two different rates of rotation of the disc. The latter measurement it is easy to make with accuracy, for the movable electrode may be rigidly attached to the movable headstock of a Whitworth measuring machine or some other measuring bank placed parallel to the length of the trough; and the two equilibrium positions may be taken near the middle of the trough so as to avoid danger of curvature in the equipotential surfaces passing through the electrode in its two positions.

Let  $n_1, n_2$  be the rates of rotation of the disc, and let  $l$  be the distance between the corresponding equilibrium positions of the movable electrode.

$$\text{Then} \quad M(n_1 - n_2) = \frac{l}{A} \rho$$

where  $\rho$  = the specific resistance of mercury.  
 $A$  = area of section of the mercury column.

But we are met by a new difficulty, the determination of the section of the mercury column. The capillary depression at the sides of the trough would make it a most serious task to determine the section by direct measurement to the required degree of accuracy.

Fortunately, this difficulty may be overcome by a further differential method, viz., by making observations with the mercury at two different heights in the trough.

Let  $b$  = the breadth of the trough;  
 $h_2 - h_1$  = the difference of height of the mercury surface in the two cases;  
and let  $A$  = the section of the mercury column when the mercury is at the lower position.

Then we have, denoting by dashed letters, the new values of the rates of rotation and the distance between the corresponding equilibrium positions—

$$M(n_1 - n_2) = \frac{l}{A} \rho$$

$$\text{and} \quad M(n'_1 - n'_2) = \frac{l'}{A + b(h_2 - h_1)} \rho$$

whence eliminating  $A$

$$\rho = \frac{M b (h_2 - h_1)}{l' - \frac{l}{n'_1 - n'_2} - \frac{l}{n_1 - n_2}}$$

It is assumed in the above formula that the sides of the trough in that part of it traversed by the movable electrode are plane, parallel, and vertical.

Hence the determination of the specific resistance involves the determination of:—

- (i.) Four equilibrium positions, two at each depth, with the rates of rotation of the disc to which they correspond.
  - (ii.) The breadth of the trough in that part of it traversed by the movable electrode.
  - (iii.) The difference of level of the mercury surface at the two depths.
  - (iv.) The coefficient of mutual induction of the coil and disc.
- The difficulties attached to the determination of equilibrium positions and the coefficient of mutual induction belong to all forms of Lorenz's method, whether the resistance measured is that of a solid conductor or that of a mercury column. Those specially incident to the use of a mercury column are:—
- (i.) The manufacture of an accurate trough, and
  - (ii.) The accurate measurement of the difference of level of the mercury surface in its two positions.

The trough used by me in the experiments of which I have spoken, was cut in paraffin wax contained in a strong casting of iron with its sides strengthened by outside ribs. The channel is approximately 43.5 inches long, by 1.5 inches broad, by 3 inches deep. It was first cut by a cutter rotating about 2,000 times a minute, attached to the slide rest of the College Whitworth Lathe, and subsequently finished by a scraper, attached in similar fashion, which took a very thin cut off sides and bottom. The result of the scraping was a very smooth and highly finished surface.

This method of obtaining a channel for the mercury was adopted in the hope that so cut in the lathe it might present a breadth constant to two or three ten thousandths of an inch. This hope was not realised: the results of subsequently calibrating the trough over the 10 inches of it traversed by the movable electrode indicated a variation of as much as .001 inch in its breadth. The objections to the use of paraffin wax are:—

(i.) Its softness makes it necessary to proceed with great care in measuring its breadth, lest damage should be done to the surface. This difficulty is satisfactorily surmounted in the form of internal callipers adopted in the calibration, which I must not stay to describe.

(ii.) The coefficient of expansion of paraffin wax is very large, its linear coefficient of expansion being about .0003. A change of temperature would, therefore, cause distortion in the wax channel seeing that the wax is enclosed in an iron casing.

We endeavoured to meet the danger of inaccuracy due to this cause by measuring the breadth of the trough as nearly as possible at the same temperature as that at which the electrical observations were made, care being taken to maintain the trough at a uniform temperature throughout the observations. During the month of the observations, the temperature inside the box in which the trough was placed, did not vary more than half a degree. But, notwithstanding this care, I am of opinion that the difference in the result of different sets of observations depends in the main upon variations in the trough due to varying temperature. But it is impossible to apply a correction, for paraffin wax is so bad a conductor of heat that its temperature could not be assumed to be that of the thermometers in the mercury channel; its temperature at any part would really be a function of ancient history.

Under these circumstances, I have come to the conclusion that I made a mistake in my choice of a substance; the disadvantages outweigh the apparent ease of construction. Probably a much more satisfactory result would be obtained by building up the trough of worked glass or scraped marble. I do not doubt that a sufficiently accurate trough might be made in either of these substances without straining the resources of the English mechanical engineer. We may observe that small errors become of less importance as the breadth of the trough is increased; and nothing but practical convenience limits the size of the trough we may employ, provided it is long enough in proportion to its breadth to make the equipotential surfaces plane over the part of it traversed by the movable electrode. It is further to be noticed that it is only the latter part of it that needs to be finished with the highest accuracy, and when the mechanical engineer has done his best, it is still possible to obtain a further approximation by a process of calibration.

The position of the mercury surface in the trough may be determined electrically by means of a pointed steel spherometer screw. The screw may be moved downwards until an electric circuit, comprising the screw and the mercury, is completed. It is of the utmost importance that the point of the screw should be kept clean, and that the mercury surface should be free from an oxide film, otherwise successive observations may differ from one another as much as .001 inch; but with clean mercury, if the point is carefully wiped with filter paper before making the observations, half a dozen observations may be without difficulty obtained, none of which differ from the mean by more than .00004 inch. To preserve the point, sparking at the mercury surface should be reduced as much as possible.

In order that the capillary surface should be of the same shape at both levels, the surface should always be brought to its measured position by pouring mercury into the trough, and never by taking mercury out of it.

I am of opinion that both the measurements to which I have referred as peculiar to the direct use of mercury by the differential method—viz., that of the breadth of the trough and that of the difference of level of the mercury surface—may be made with an

accuracy which will compare favourably with that which we can hope for in the determination of the equilibrium position; and, perhaps, also with that which we may expect in the measurement of the coefficient of mutual induction—measurements which are common to all forms of Lorenz's method.

Probably, also—though here I speak with hesitation and without experience—the accuracy will be as great as, if not greater than, that which attends the calibration of a glass tube, necessary to the determination of the specific resistance of mercury in B.A. units.

The electrical observations in Lorenz's method consist, fundamentally, in the determination of equilibrium positions, together with the rates of rotation to which they correspond. The equilibrium position is obtained when, if the direction of the current is reversed through the standard coil and trough, the reading of a galvanometer inserted in the disc circuit is unaffected. In the experiments I have made, I have found it best—following Lord Rayleigh—to take two sets of galvanometer readings for each equilibrium position, one set giving the change of galvanometer reading corresponding to reversal of the battery current for a position of the electrode slightly to one side of the equilibrium position; the other, the change of galvanometer reading, corresponding to reversal for a second position slightly on the other side of the equilibrium position. The galvanometer reading corresponding to the two positions of the commutator being called  $\epsilon$  and  $w$ , passage through an equilibrium position is indicated by a change in the algebraic sign of  $w - \epsilon$ . When  $w - \epsilon$  has been found for two positions slightly differing from one another, and including between them the equilibrium position, the latter may be found by simple interpolation. Since the readings,  $\epsilon$  and  $w$ , are not quite fixed, owing to small changes in the speed of the disc and variations at the brush contacts, it is necessary to take a number of reversals and to find  $w - \epsilon$  as the mean of the values obtained by combining the first value of  $\epsilon$  with the first of  $w$ , the first of  $w$  with the second of  $\epsilon$ , the second of  $\epsilon$  with the second of  $w$ , &c. The more quickly the reversals can be made to succeed one another, the better will be the results, for with rapid reversal variations in the position of the needle corresponding to no current through the standard coil (i.e., variations due to change at the brush contacts), are less likely to supervene. It is, therefore, best not to wait for the needle to come even approximately to rest after the disturbance due to the induction current on reversal, but to take the readings for the extreme positions in an oscillation, and having previously found the coefficient of damping, to calculate the position of rest from these two readings.

The whole difficulty in determining an equilibrium position arises from the want of constancy in the readings  $\epsilon$  and  $w$ ; and this want of constancy is due to two causes:—

1. Variations in the electromotive force at the brush contacts.
2. Variations in the rate of rotation of the disc.

It was with a feeling akin to despair that I watched the dance of the galvanometer needle during the first running of my apparatus, when the brush at the circumference of the disc was composed of a number of layers of thin phosphor bronze sheet controlled by a spring, and the dance continued, however well the circumference of the disc and brush were amalgamated at starting. Trials were made in the hope of improvement with amalgamated copper and amalgamated lead, and with the substitution of a dead weight pressure for the spring. But no satisfactory result could be obtained. It was noticed, however, that after amalgamation the readings were fairly steady for a short interval, and it occurred to me that if mercury could be continuously supplied to the surface of contact between the brush and the disc, this steadiness might be maintained. This led on to the idea of a brush consisting of a single wire perforated by a channel through which a constant flow of mercury might be maintained from a cistern of adjustable height; and a brush of this description was finally adopted. It presents very great advantages over any other form of brush tried.

Prof. Rowland used three brushes on the circumference instead of one, and I do not doubt that a multiplication of brushes is advantageous. Three or more such brushes as I have described, resting by dead weight pressure on the circumference of a disc ground true in place would, I believe, give an excellent result. The grinding of the disc in place is an important aid to steadiness of galvanometer reading.

It is to be noticed that the value of  $w - \epsilon$  for a position at a given distance from the equilibrium position is proportional to the current through the standard coil. Hence the small variations due to the brush contacts which do not at all depend on the current through the coil become proportionately of less importance as the current is increased. We ought, therefore, from this point of view, to use as large a current as possible. But the magnitude of the current is limited by the fact that it has to traverse the wire of the standard coil, which must not be made so hot as to risk the destruction of its insulation. This consideration points to the use of wire of considerable diameter in the standard coil.

If the wire of the coil is made of large diameter, attention must be paid to the influence on the coefficient of mutual induction of the non-coincidence of the current with the axis of the wire.

The second cause of want of steadiness in the galvanometer needle is variation in the rate of rotation of the disc; and this is the real crux. We are not helped in determining the equilibrium position either by increasing the sensitiveness of the galvanometer or the magnitude of the current through the coil, unless we procure a corresponding increase of steadiness in the running of the disc. We may increase the value of  $w - \epsilon$  for a position at a given distance from an equilibrium position in either of these ways,

but unless there is a corresponding improvement in the constancy of the disc rotation no advantage results, for the variations in  $w$  and  $\epsilon$  resulting from changes of speed are proportional to  $w - \epsilon$ . Hence in the construction of apparatus for a new determination mechanical engineers should be invited to do their very best to procure a constant rotation. No time or trouble spent in securing this will be lost for the purpose in view.

In my experiments the disc was turned by an electromotor directly coupled to it, and driven from a battery of secondary cells. Each bearing was fitted with sight feed lubricators, and a heavy steel flywheel was attached to the motor. The current passed to the motor through resistance coils, and could be varied continuously through a small range by a slide resistance of platinum wire, after the larger adjustment had been made to obtain a speed, approximately that which was required. A shunt worked by a lever also provided the means of taking out or putting in a small resistance suddenly, so as to allow the observer taking note of the speed to counteract small variations, due to alteration in the lubrication of the bearings.

To obtain improved steadiness, the chief point needing attention is lubrication. Some forced system of lubrication may be employed. Either oil may be pumped through the bearings, or they may be fed from a cistern placed at some height above them. Attention might also be directed to the friction of the brushes on the motor commutator. I do not think we can look hopefully to an increase of steadiness from the employment of any hand brake controlled by the observer, for the mischief is done, and the alteration has come about before he observes that it is his duty to put the brake on or off. In fact, the galvanometer needle picks up the alterations much sooner than the observer's eye. An electro-magnetic brake might be useful for adjusting the speed, but could not give any additional steadiness to the galvanometer needle. This can, I think, only be procured by perfection of mechanical workmanship, and increased attention to the truth of all rubbing surfaces, and their proper lubrication.

It remains to speak of the measurements necessary to enable the calculation of the coefficient of mutual induction to be performed. To facilitate an accurate determination of the mean radius of the standard coil, I desire to suggest that it should be a coil consisting of one layer of wire. The advantage in constructing a standard coil with a single layer of wire is that every part of it is visible, and that nothing is done to alter the position of the wire after measurements are made. If a coil consists of many layers, it is not quite easy to say where, after measurement, the lower layers go to under the pressure of the superincumbent layers. Lord Rayleigh found, in the case of certain coils used by him, that the mean radius calculated from measurements made in winding was greater by one part in 2,000 than the mean radius calculated from measurements made in unwinding, a result clearly due to the compression of the lower layers by the layers above them.

We should, therefore, expect that if the mean radius of a coil of many layers is calculated from measurements made in winding, it will be reckoned too large. In the face of this, it is interesting to note that in the measurements made by Lord Rayleigh by the method of Lorenz, the series in which the coils are so placed as to make the induction coefficient nearly independent of the mean radius, gives a result rather larger than the other series, which is what might be expected, if the mean radius is over-estimated. But the smallness of the variation (a little over one part in 10,000), seems to show that the error of mean radius must be very small for the pair of coils used by Lord Rayleigh. In general, we should expect as far as this cause goes, that values of the specific resistance in determining which coils of many layers are used would come out too low, since an overestimate of the mean radius of the coil means an underestimate of the coefficient of mutual induction. The apparent disadvantage of a coil of a single layer is that the number of turns will be fewer and, therefore, the coefficient of mutual induction of the coil and disc smaller than in the case of a coil of many layers. We may, however, in order to get a sufficient number of turns, make the coil of greater axial length than has been customary. But we cannot, in that case, use Lord Rayleigh's formula of approximation in calculating the coefficient of mutual induction. Under these circumstances, a new formula, applicable to a coil of moderate axial length, was a desideratum. Such a formula I obtained by

the direct integration of the expression  $\iint \frac{ds ds'}{r} \cos \theta$  for a circle and coaxial helix.

It is of the form

$$M = -8\pi n \frac{Aa}{A+a} \sum (-1)^m \frac{1.3.5 \dots 2m-1}{2.4.6 \dots 2m} \cdot \frac{1}{2m+1} \left( \frac{a}{A+a} \right)^{2m} P_m,$$

Where  $A$  = the radius of a circular section of the cylinder determined by the helix.

$a$  = the radius of the circle.

$n$  = the number of turns of the helix.

$2x$  = the axial length of the helix.\*

and

$$P_m = \int_0^{\pi} \frac{\cos 2\theta d\theta}{(1 - c^2 \sin^2 \theta)^{\frac{2m+1}{2}}}$$

\* *Phil. Mag.*, January, 1889. Read before Physical Society, November 10th, 1888.

when

$$c = \frac{2 \sqrt{\Delta a}}{A + a}$$

$r_m$  may be expressed in terms of  $c$ ,  $F(c)$ , and  $K(c)$ .

This is the formula I have used in calculating the coefficient of mutual induction of the coil and disc in the experiments already mentioned. The coil is of double silk covered copper wire of about .02 inch diameter, resting in a screw thread of .025 inch pitch, cut on a hollow cylinder of brass of about 21 inches external diameter. The axial length of the cylinder is something over 4.5 inches, and 185 turns of wire are wound on it. The disc has a radius of about 6.5 inches, and the coefficient of mutual induction is about 17,000 inches. This is a little more than a tenth of the coefficient of mutual induction of the coils and disc used by Lord Rayleigh in the first and second series of his experiments by the method of Lorenz, but it was found to be ample for the purpose in hand.

The mean radius of the coil was measured in the Whitworth measuring machine.

Uncertainty arose from two causes:—

- (i.) The silk covering of the wire;
- (ii.) The ellipticity of the coil cylinder.

The silk covering of the wire is of slightly varying thickness, and suffers compression to a varying extent during a series of measurements.

A standard coil, consisting of naked wire wound in a screw thread cut on a cylinder of insulating material, would be preferable to one of covered wire wound on a metal cylinder. There is, however, difficulty in finding a suitable insulating material. Wood immediately occurs to one's mind, but a large coil of wood, even though it be built up many pieces, is apt to change its shape with age and varying atmospheric conditions. But if a suitable insulating material, that can be turned true and that will retain its shape can be found, a single layer of naked wire in a screw thread cut on a cylinder of this material, would give us a coil the mean radius of which might be easily measured with certainty in the Whitworth machine to far more than one part in ten thousand.

The ellipticity of the coil cylinder deserves notice. The cylinder was turned with great care in the lathe already mentioned. It was cast with three lugs by which to bolt it to the face plate, and subsequently in precisely similar fashion to the strong brass frame which serves as its support during use. The first operation was roughly to fit the lugs to the face plate by filing. A roughing cut was then taken over the entire surface of the cylinder, so as to get rid of as much as possible of the internal strain due to unequal cooling of the casting. It was next unbolted and the lugs were carefully scraped to fit the face plate, and after again bolting it to the face plate the final turning was proceeded with. Very fine cuts were taken in finishing, and it was hoped that by these precautions we should secure a true right circular cylinder. Nevertheless measurements made in the Whitworth measuring machine show that the section of the cylinder at right angles to its axis is slightly oval. The longest diameter is 21.1056, and the shortest 21.0898, from which it appears that there is a difference of about .008 inch between the longest and shortest radius. It appears, indeed, to be a task of no ordinary difficulty to turn a cylinder of large size that shall remain true to the thousandth of an inch. Every fresh cut seems to alter its internal equilibrium, and after the cut is complete it adjusts itself to a new shape. The remedy lies in having a sufficiently massive cylinder carefully annealed to work on, and a fund of patience to make the requisite number of fine finishing cuts with a sufficient interval of time between them. In conclusion, the main suggestions I have to offer for consideration are the following:—

- (I.) That the time is ripe for a new determination of the ohm that shall be final for the practical purposes of the electrical engineer.
- (II.) That such a determination may be made by the method of Lorenz, the specific resistance of mercury being obtained directly in absolute measure by the differential method described.
- (III.) That the standard coil should consist of a single layer of wire, the coefficient of mutual induction of the coil and disc circumference being calculated by the new formula.

#### DISCUSSION.

Mr. SWINBURNE having suggested certain alterations in the moving parts of Prof. Jones's apparatus,

Lord RAYLEIGH said that he was very much interested in the paper. When he first planned observations by the method of Lorenz, he naturally cast about to see whether he could imitate him and deal as Prof. Jones had done, with an actual column of mercury. He found certain difficulties which at the time choked him off, and which Prof. Jones had overcome. He was quite conscious that good results might be obtained in that way, and it was of great interest to obtain them in that way. This was a distinct variation from the methods used by others. Here they had mercury brought directly into the absolute measurement. He was not quite sure whether he rightly understood Prof. Jones as to the manner in which connection with the mercury column was made. He thought as far as he did understand him, the movable electrode of which he spoke, was the one which actually carried the main current.

Prof. JONES said the current through the standard coil was introduced to the mercury by thick iron plates at the end of the open trough.

Lord RAYLEIGH thought that that arrangement commended

itself to them. What he attempted was as follows:—He took a closed tube of about 1 inch in diameter, and in order to get lateral connections he divided it, cutting it as clean as he could at two places into three parts, and then filing away a little bit of the edge, put them together with cement, leaving in that way the cavities through which the lateral wires could be introduced. He thought the amount of disturbance of the regular sections induced in that way was not much; and he was sure if it were gone into in a careful manner, good results would be obtained. Prof. Jones had used an open trough with a free surface in order to eliminate the effect of meniscus, by a differential arrangement of which the depth was varied. His only remark as to that would be that, as Prof. Jones explained it, it seemed to require four observations to get a result. That rather accumulated errors of reading, though not to a serious extent probably. He had very little doubt that by this method extremely accurate results might be got; and, no doubt, if Prof. Jones pursued the subject, he might obtain a degree of accuracy surpassing any yet obtained. He was not sure whether so high a degree of accuracy was very important at the present moment. No doubt they would like to get a greater degree of accuracy than they had obtained; but he was not sure that there were any other measurements with which that could be brought into comparison. Supposing they could, how could they use the number unless in comparison with other numbers obtained in other physical measurements? Nothing definite would follow from it, and if they used it for electrical purposes they had to face the difficulty of comparing wire with mercury. The only other point was as to the question of the temperature of the mercury. When a comparatively thin tube filled with mercury was used, there was no difficulty in immersing it in ice. Was the mercury in Prof. Jones's apparatus at zero?

Prof. JONES: No. 15.5°.

Lord RAYLEIGH: Then it depends upon the change in mercury.

Prof. JONES: Yes. The speaker went on to say that he used the formulæ of Mascart and Benoit.

Lord RAYLEIGH said that that correction could be made with a great degree of accuracy, but it took away from the method that consisted in the comparison. However, there could be no doubt of the very great interest of getting that result direct in terms of mercury without the inconvenience of any other standard, and he hoped Prof. Jones would pursue it.

Sir WILLIAM THOMSON mentioned one point as a source of error, viz., meniscus. Prof. Jones said that the meniscus was taken as the result of adding to the mercury in each case. If it was so finely balanced as that, he would be afraid that even tapping it during experiments would alter the level of the surface and induce error. No doubt Prof. Jones attended to that, but it was necessary to make quite sure that the error from meniscus did not sensibly vitiate the result, and if it did, by how much? As to temperature, he should think that its determination might be got with great accuracy by thermometers placed in the mercury itself at considerable distances in the parts subject to the differential test; two or three points at some distance from where the mercury was tapped would do. He was glad that Lord Rayleigh advised Prof. Jones to pursue the method which seemed, so far, exceedingly satisfactory.

Lord RAYLEIGH said he meant to have expressed his appreciation of the advantage of being able to reduce a coil to a single layer. No one who had measured a coil would doubt that. There was a question of the uniformity of the winding in the other direction—whether the windings were uniform along the axis? Prof. Jones said that they were laid on a screw throughout.

Prof. JONES briefly replied on the remarks made.

#### ON ALTERNATE CURRENTS IN PARALLEL CONDUCTORS OF HOMOGENEOUS OR HETEROGENEOUS SUBSTANCE.

By Sir WM. THOMSON.

(Read before Section A, September 5th, 1890.)

THIS paper consists of a description of some of the results of a full mathematical investigation of the subject which I hope to communicate to the *Philosophical Magazine* for an early number.

1. Two or more straight parallel conductors, supposed, for simplicity, to be infinitely long, have alternating currents maintained in them by an alternate current dynamo, or other electromotive agent applied to one set of their ends at so great a distance from the portion investigated, that in it the currents are not sensibly deviated from parallel straight lines. The other set of ends may, indifferently in respect to our present problem, be either all connected together without resistance, or through resistances, or through electromotive agents. All that we are concerned with at present is, that the conductors we consider form closed circuits, or one closed circuit; and that, therefore, the total quantities of electricity per unit of time at any instant traversing the normal sections in opposite directions are equal.

2. We suppose the period of the alternation to be very great in comparison with the time taken by light to traverse a distance equal to the greatest diameter of cross-section of our whole group of conductors. This supposition is implied in the previous assumptions of parallel rectilinearity of the electric stream-lines, and of equality of the quantities of electricity traversing, in opposite directions, the several areas of a normal section.

3. We farther suppose that the length of our conductors and

their effective ohmic resistances, are so moderate,\* that the quantities of electricity deposited on, and removed from, their boundaries to supply the electrostatic forces along the conductors required for producing the alternations of the currents, are negligible in comparison with the total quantity flowing in either direction in the half-period. This supposition excludes important practical problems of telegraphy and telephony, the problem of long submarine cables for instance, but it includes the problem of electric lighting by alternating currents transmitted at high tension through considerable distances, as, for example, from Deptford to London.

4. The general investigation includes as readily any number of separate circuits of parallel conductors, as a single circuit, but for simplicity in describing results, I suppose our system of conductors to be so joined at their ends as to constitute a single simple circuit of two parallel conductors.† It may be either two conductors or one conductor, one of which may or may not surround the other, as shown in figs. 1 and 2, representing cross sections. Each conductor may be single, as in figs. 1 and 2; or either may be multiple parallels.

5. We suppose each conductor to be homogeneous in substance and in cross section from end to end, but not necessarily homogeneous in different parts of the cross section. Thus the different

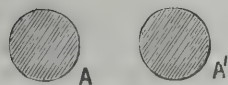


FIG. 1.

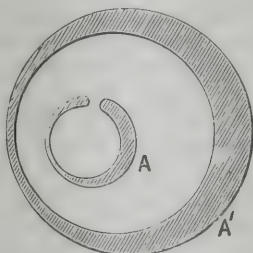


FIG. 2.

conductors, or the different parts of either, may be of different metals, or either conductor, or any part of either conductor, may consist of two metals (as iron and copper or iron and lead) laid parallel and soldered together.

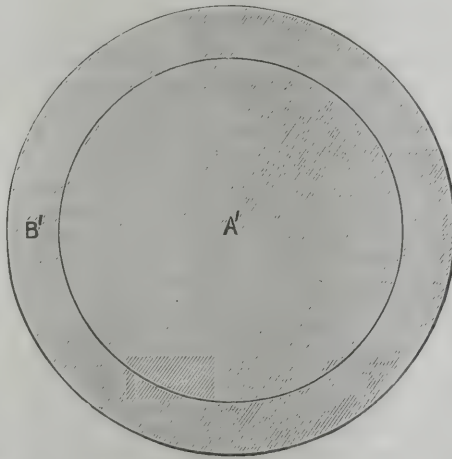
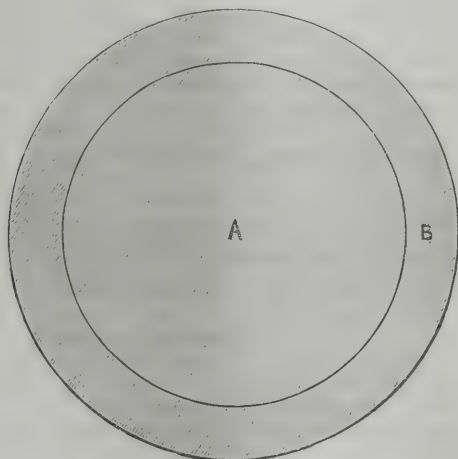


FIG. 3.

6. We shall call A and A' the cross sectional areas, or groups of areas of the two conductors, respectively, of the other. All the different portions of A are connected metallically at their two ends, and are thus all of them at one potential at one end and

\* The circumstances in which this condition is fulfilled may be usefully illustrated by considering the important practical cases of submarine cables, and of metallic circuits of two parallel wires insulated at a distance anything less than a few hundred times their diameter. For all these cases the numeric expressing the electrostatic capacity per unit length of either conductor (the other supposed for the moment to be at zero potential) is between 2 and 0.1, and for our present rough comparison may be regarded as moderate in comparison with unity. On this supposition the condition of the test requires for fulfilment that the mean proportional between the velocity which expresses in electro-magnetic measure the resistance of one of the conductors, and the velocity of a body travelling the length of the conductor in a time equal to half the period of alternation shall be exceedingly small in comparison with the velocity of light.

† The case of a single circuit made up of parallel conductors, so joined at their ends that to travel once round it we must go and come two or three or more times along separate conductors, joined by their ends in series, so as to make one circuit, is specially considered in my paper on "Anti-Effective Copper in Parallel or in Coiled Conductors for Alternating Currents," to be communicated presently to Section A.

another potential at the other end, and similarly for A'. The homogeneity of the material and of the cross sections along the length of the conductors, and the uniformity of the total currents assumed in Section 3, implies that all the different parts of A in one cross sectional plane are at one potential, even though A consist of mutually isolated parts, or A' consist of mere isolated parts. If, as in figs. 1 and 2, all the parts of A are in mutual metallic connection, and all the parts of A' are in mutual metallic connection, this would entail uniformity of potential through A, and uniformity of potential through A', even without the limitation of our subject laid down in Section 3.

7. The following are among some of the most noteworthy results of the full mathematical treatment of the subject:—

I. When the period of alternation is large in comparison with 400 times the square of the greatest thickness or diameter of any of the conductors, multiplied by its magnetic permeability, and divided by its electric resistivity, the current intensity is distributed through each conductor inversely as the electric resistivity; the phase of alternation of the current is the same as the phase of the electromotive force; and the current across every infinitesimal area of the cross-section is calculated, according to the electromotive force at each instant, by simple application of Ohm's law.

II. When the period is very small in comparison with 400 times the square of the smallest thickness or diameter of any of the conductors, multiplied by its magnetic permeability, and divided by its electric resistivity, the current is confined to an exceedingly thin surface stratum of the conductors. The thickness of this stratum is directly as the square root of the quotient of resistivity, divided by magnetic permeability of the substance in different parts of the surface, but the total quantity of the current per unit breadth of the surface is independent of the material, and, except in such cases as those referred to at the end of II, below, varies in each cross section in simple proportion to the electric surface density of the static electrification induced by the electromotive force applied between the extremities for maintaining the current. The distribution of this electric density is similar in all cross sections, but its absolute magnitude at corresponding points of the cross section varies along the length of the conductor in simple proportion to the difference of electric potentials between A and A', and is zero at one end in the particular case in which the conductors are connected through zero resistance at one end while the electromotive force is applied by an alternate current dynamo at the other end. On the other hand, the surface-distribution of

electric current is uniform throughout the whole length of the conductors, and it is only its distribution in different parts of the cross-section that varies as the electric density.

The proportionality of surface intensity of the current to electric density, asserted above, fails clearly in any case in which the circumstances are such that the distance we must travel along the surface to find a sensible difference in electric density is not very great in comparison with the thickness of the current-stratum. Such a case is represented in fig. 3, which is drawn to scale, for alternate currents of period  $\frac{1}{100}$ th of a second in round rods of copper of 6 cms. diameter. The spaces between the outer circular boundaries and the inner fine circles, indicate what I have called the mhoic thickness,\* being  $\frac{1}{714}$  of a centimetre for copper of resistivity 1611 square centimetres per second. The full solution for such a case as that represented in fig. 3, belongs to the large class of cases intermediate between I. and II., and could only be arrived at by a kind of transcendent mathematics not hitherto worked. But without working it out, it is easy to see how the time-maximum intensity of the current will diminish inwards from the surface, and will be, at any point of either of the inner fine circles, about  $\frac{1}{2}$  or  $\frac{1}{3}$  of what it is at the nearest point of the boundary surface; and that at points in the surface, distant from B B' by one-half or one or two times the mhoic thickness, the current intensity will be much smaller than it is at B B'.

III. In case I. the heat generated per unit of time, per unit of

\* Collected Papers, Vol. III., Art. CII., § 35.

volume, in different parts of the conductors, is inversely as the electric resistivity of the substance, and directly as the square of the total strength of current at any instant. In case II. the time-average of the heat generated per unit of time, per unit of area of the current stratum, is as the time-average of the square of the quantity of current per unit breadth, multiplied by the square root of the product of the electric resistivity into the magnetic permeability.

IV. Example of II.—Let the conductor,  $A$ , be a thin flat bar, as shown in the diagram (fig. 4),  $A'$  being a tube surrounding  $A$ , or another flat bar like  $A$ , or a conductor of any form whatever, provided only that its shortest distance from  $A$  is a considerable multiple of the breadth of  $A$ . The thickness of  $A$  must be sufficiently great to satisfy the condition of II., and its breadth must be a large multiple of its thickness. (For copper carrying alternating currents of frequency 80 periods per second, these conditions will be practically fulfilled by a flat bar of 4 cms. thickness, and 30 or 40 cms. breadth). The current in it is chiefly confined to two strata extending to small distances inwards from its two sides. (For copper and frequency 80 periods per second, the time maximum of intensity of the current at the surface will be about  $e^2$ , or  $7\cdot4$ , times what it is at a distance  $1\cdot43$  cms. in from the surface. The quantity of current per unit breadth, or as we may for brevity call it, the surface-density of the current in each stratum, is determined by the well-known solution of the problem of finding the surface electric density of an electrified ellipsoid of conductive material undisturbed by any other electrified body. The case we have to consider is that of an ellipsoid whose longest diameter is infinite, medium diameter the breadth of our flat conductor, and least diameter infinitely small. In this case the electric density varies inversely as  $\sqrt{(o B^2 - o P^2)}$ . The graphic construction in the drawing shows  $PQ = \sqrt{(o B^2 - o P^2)}$ , and we conclude that the time-

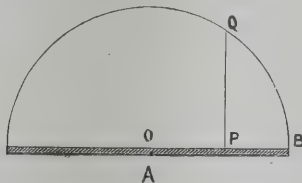


FIG. 4.

maximum of the surface density of the current varies inversely as  $PQ$ . The infinity which in the electric problem we find for electric density of the ideal conductor, is obviated for the electric current problem by the proper consideration of the rectangular corners, or the rounded edge (as the case may be), of our copper bar, which, though exceedingly interesting, is not included in the present communication. Suffice it to say, that there will be no infinities even if the corners be true mathematical angles.

V. Examples of cases I. and II.:—Let  $A$  consist of three circular wires,  $c$ ,  $l$  and  $i$ , of copper, lead, and iron respectively. In case I., the quantities of the whole current they will carry, and the quantities of heat generated per unit of time in them, will be inversely as their resistivities. In case II., if the centres of the three circular cross-sections form an equilateral triangle, the quantities of heat generated in them will be directly as the square roots of the resistivities for  $c$  and  $l$ ; and for  $i$  would be as the square root of the product of the resistivity into the magnetic permeability, if the magnetic permeability were constant and the viscous or frictional resistance to change of magnetism nothing for the iron in the actual circumstances. This last supposition is probably true, approximately, with a permeability of  $\frac{1}{100}$ th for iron or steel, according to Lord Rayleigh, if the current is so small that the greatest magnetising force acting on the iron is less than  $0\cdot1$  C.G.S.

VI. The dependence of the total quantity carried, on extent of surface, and on the solution of the electrostatic problem described in II, justifies Snow Harris, and proves that those who condemned him out of Ohm's law were wrong, in respect to his advising tubes or broad plates for lightning conductors, but does not justify him in bringing them down in the interior of a ship (even through the powder magazine), instead of across the deck and down its sides, or from the masts along the rigging and down the sides to the water. The non-dependence of the total quantities of current on the material, whether iron or non-magnetic metals, seems quite in accordance with Dr. Oliver Lodge's experiments and doctrines regarding "Alternative Path" and lightning conductors. The case of alternate currents is, of course, not exactly that of lightning discharges; but from it, by Fourier's methods, we infer main conclusions of II. and V., whether the discharges be oscillatory or non-oscillatory, provided only that it be as sudden as we have reason to believe lightning discharges are.

## DISCUSSION.

Prof. ROWLAND said that he had considered these alternating currents in parallel conductors, and he believed he gave a theorem with regard to the distribution in the case of perfect conductors. He thought that that was the only case in which the problem could be solved. In that case the distribution was exactly the same as it would have been if they had been charged with electricity at rest; and there was some theorem, which he had almost

forgotten now, with regard to the self-induction and the capacity. In that special case the self-inducting capacity. Of course, that was a much more limited problem than that Sir William Thomson had given, but he thought it led to interesting results. It guided them in their ideas with regard to the distribution, because in the case of perfect conductors the distribution of the current was exactly the same as the distribution of the density in the case of conductors at rest, so making the conductivity a little less than that; and they were guided to some extent by that theorem. He did not know that any solution had ever been obtained in the case where the conductors were not perfect, but Sir William Thomson, he considered, had found a solution of that nature.

## CORRESPONDENCE.

## Hysteresis.

I have not much to say about this subject, which is occupying many of our minds, but I must kindly be allowed to call the attention of those of your readers who are interested in the subject to a short but remarkable paper by Prof. Ewing in the *Philosophical Magazine* for this month; it is simply charming.

The manner of expression, and total absence of mathematical gas and turnpike roads, which is so often apparent in such work, is not only to the advantage of many who want the crop, but who cannot, for different reasons, follow the plough and harrow; but in other respects it is so highly suggestive, and so face-to-face in its experimental truth, that its effect upon intelligent readers must be more than ordinary; it is more than probable that from it they will learn more of magnetism than from their past digestion of tons of theories. I am glad Prof. Ewing has mentioned his line and fields of magnetic needles, and expandable base of rubber to shift their centres, the development of magnetic swing into "rotation," the lag explanation, and critical temperatures; but I will not go further, but promise everyone one of the finest scientific treats from a perusal of Prof. Ewing's latest magnetic contribution.

James C. Richardson.

September 9th, 1890.

P.S.—In the same number is an elaborate account all about glow-worms, which may also interest many who think we get too few light rays from our lamps.

## Electric Launches.

Much is often said of the advantages of electric launches, and comparisons are drawn between them and steam launches, to the great disadvantage of the latter. I have no particular partiality to the steam launch, and think it often a great nuisance to boating men on the Thames, but I am not aware that a great drawback to the use of some electric launches has been noted, namely, *the smell*. This, if present, has not been noticed by me in connection with the larger launches, but there is a small launch which may often be seen not 15 miles from London, which is a great sinner in this respect. In pulling down stream a few days ago, with the wind blowing towards me, I recognised the presence of this boat some hundreds of yards before reaching her, and remarked upon it to a friend who was steering; he said he could see nothing of her; but shortly after, we passed her towing a boat almost as large as herself. This nuisance is, of course, from the acid in the cells. I do not know what type is in use, but such a boat is a bad advertisement for the electric launch business.

E. R. Dolby.

September 9th, 1890.

**The Electric Light in Portsmouth.**—The *Portsmouth Times* regards this as inevitable, and says that vested interests, referring to the Portsea Island Gas Company, must not be allowed to stop the way.

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FIRE RISK RULES.

"SUCH rules should be based on the deductions of experiment and the teaching of experience. They should give the utmost freedom of action and encourage progress. They should contain the minimum that is necessary, and this should be strictly enforced. Above all, these rules should be in accordance with the general principles which regulate all successful engineering constructions. For example, if we consider such familiar, but different structures as a locomotive engine, a steamer, or a bridge, we observe that there is no absolute safety in any one of them. Each has been perfected, not by directing the mind to a particular class of facts, but by a judicious compromise between many conflicting necessities, by giving neither more nor less than a just measure to each requirement, and in each case, all this has had to be done with due economy and limited means. In this spirit all fire insurance regulations should be framed."

This is the concise manner in which Mr. Wilson Hartnell summed up the requirements of fire risk rules and regulations when, before the British Association, he pointed out some much-needed amendments in those now existing ; and it is on his admirable paper, and the correspondence on the same subject in the *Times*, which has extended in a fitful manner over a period of some weeks, that we purpose offering a few comments. This, however, will not be so much with a view of suggesting any technical alterations, but rather from a desire to bring about the necessary feeling of compromise amongst the conflicting interests which now render the proper carrying out of electric lighting installations a matter of no small concern.

Mr. Hartnell condemns any attempt on the part of insurance companies to determine a fixed current density in conductors as "useless, vexatious, and scientifically wrong," and on this point we cordially agree with him, and would urge upon the various companies' technical experts not only the advisability, but the absolute necessity, of substituting for the clauses

dealing with the sectional area of conductors others based upon scientific principles.

When the subject of insulation is dealt with, it is not quite so easy to follow the ideas which presented themselves to the author's mind. That the chief object of electric light insulation is safety, and that this should continue for as many years as possible, is doubtless the view entertained by all electrical engineers ; but Mr. Hartnell seems likely to be misunderstood when he says that he considers durability of far more consequence than high insulation. The term "high insulation" is, of course, a relative one only ; but surely that very durability upon which so much stress is laid depends upon good and, probably, according to the material used, high insulation ? It, therefore, seems to us that Mr. Hartnell is in error in trying to dissociate the one from the other, although we concur in his opinion respecting the advantages of naked wires on insulators. So far as his distrust of vulcanised India-rubber goes, we would not like to say that it is entirely untenable ; on the other hand, evidence as to its superiority over all other kinds of insulation for electric light leads could doubtless be produced in abundance.

The question as to what wires will pass the insurance companies is perhaps the most vital point of all for the contractor, and a letter which appears in our correspondence columns is only one of numerous complaints of a similar nature which have reached us from many quarters.

So far as specifying the insulation resistance per mile is concerned, there should be no difficulty whatever in this, nor should the question of dry or wet weather enter into the matter at all. All wires covered with India-rubber, gutta-percha, okonite, Callender's bituminous compound, or what not, are tested after an immersion for a given time, usually 24 hours, in water at a temperature of, generally 75° Fahr. It is necessary, owing to the effects of temperature upon the insulating materials to reduce the dielectric resistance to a standard ; and in telegraph work, whether underground or submarine, it is always taken at 75°.

What the result of testing for insulation turns out to be after the installation is completed depends not so much upon the wire, which *per se* should be just as good as when it left the manufacturers, as upon the number and nature of the apparatus in circuit, which include lamps, switches, cut-outs, joints, &c., of various kinds. Naturally the wire, through lapse of time, will not remain in the same excellent condition as when first erected, for only under water will India-rubber and gutta-percha retain their insulating properties for many years unimpaired.

The controversy in the *Times* was commenced by Major Flood Page, who, in reply to a question as to the rules which were best to adopt for wiring houses in a small provincial town, answered that he could only say that some fire insurance offices followed one set of rules, others made their own, others had none, some trusted to inspection of each risk, and that, in the interests of the public, of the contractors, and of the offices themselves, it was most earnestly to be desired that one set of rules should be adopted by all the fire insurance offices.

Furthermore, this gentleman, after a careful examination of the rules of the Phoenix office and of the Institution of Electrical Engineers, and also of the special rules of ten different fire offices, concluded that they contained no crucial difference, nor any disagreement in principle, and, while founded on the Phoenix model, the variations were mere matters of detail, none of which, so far as the gallant Major could see, made the offices which introduced the changes any safer or better for the introduction. In conclusion, he advocated the adoption of Mr. Musgrave Heaphy's classical compilation on a variety of grounds, one being that "notwithstanding the number of years these rules have been in use, not a single instance of fire has occurred from any electrical installation placed up in compliance with them." Prof. Silvanus Thompson and Mr. C. H. W. Biggs took up the cudgels in the same cause; but two gentlemen, who have had much practical experience on a subject which their opponents could only treat theoretically, brought their guns to bear upon the Phoenix rules, and knocked them considerably out of shape, although not beyond recognition.

Mr. Verity explained how a serious effort was made to compile standard rules by the Institution of Electrical Engineers some time ago, but the rules then devised never commanded general respect and gradually lapsed owing to the action of certain fire-office surveyors, who throughout maintained that it was for them to satisfy themselves of the risks they took; that they were entitled to take whatever steps they thought necessary for the protection of their offices; and that they could not recognise rules laid down by an institution in no way associated with them financially in their risks. "But," says Mr. Verity, "it is distinctly wrong to say that electric light rules concern the fire offices only. They concern the electric supply companies, as they also must be satisfied with the efficiency of house wiring before they connect it to their system; they concern the electrical contractor, who could do his work more speedily and at a lower

rate if uniform-requirements were insisted on; and they greatly concern the house occupier who wants to be left in peace, feeling that when such work has once been done he will not be disturbed again. Besides the variety of rules mentioned by Major Page as being issued by fire offices, each electric supply company has also its own set of rules which must be complied with. It may be asked, Why should a supply company require rules also, and why is the fire-office inspection not considered sufficient? I fear the reply must be that although such inspection is often carefully made, yet in many cases it is very perfunctorily performed. Moreover, fire office inspection of electric work usually deals solely with the quality of material, the system of safety fuses, switches, &c., and it would be quite a novelty for any fire-office surveyor to be seen with instruments for accurately testing as to the efficiency of the work, and yet this is just what a supply company requires."

Mr. A. A. Campbell Swinton alluded to Major Flood Page's letter in a grimly sarcastic vein:—"Among persons competent to judge, there is now no question that, given proper appliances and good workmanship, the electric light is by far the safest of all illuminants, but, at the same time, it must be confessed that the statement that no fires have occurred where the Phoenix rules have been thoroughly followed is a very safe one, as it is, at all events, open to doubt whether there ever has yet been an installation carried out in entire accordance with these rules."

Both gentlemen are agreed that Mr. Musgrave Heaphy has undoubtedly been the means of bringing about the present high standard of electrical work, and his rules must form the basis of future work in this direction. But the objections that have been from time to time raised to the Phoenix rules are that they are too many and diffusive; that they leave too much to the discretion of the surveyor, whom, from the vast amount of work, it is impossible to so frequently consult; that some of the rules are unnecessary and not desired by other leading offices; and that some of the details required simply tend to unnecessary expense, without adding to safety.

Moreover, each edition becomes more and more voluminous, and this seems likely to go on *ad infinitum*.

It appears, therefore, that what is now desirable is a set of rules which will meet the approval of both insurance and electrical supply companies, and also the needs of wiring contractors. It seems on the face of it unnecessary that supply companies should require a set of rules for their own protection, but that this is at present the case is well known, and for obvious reasons they must themselves decide whether to supply current to a house or not, even if it has passed the fire office inspectors. The insulation question is a very important one for companies supplying on the low tension system, as a bad leak in one house may interfere with the supply of a whole district, a drawback which does not enter into the transformer method, so long as the primaries are kept free from the secondary coils. It will be readily seen then that although a fire office takes the risk of the house in which a conflagration

happens to occur, still the supply company has a heavy responsibility; this, however, might be merged into the insurance companies upon the adoption of new standard rules. Now, to effect this object, there is only one obstacle to overcome, and that is to bring Mr. Heaphy to take a reasonable view of the situation. He was in the beginning guide, philosopher, and friend to the electric lighting industry; now he is the stumbling-block.

A practical committee, composed mainly of men who have had the advantage of experience to guide them, is required, but it should not contain more than eight members, half that number representing the fire offices, and the others selected from the contractors and supply companies. More than these would lead to waste of time and quibbling, and in the end the result would, like Prof. Fitzgerald's famous mathematical paper, "An episode in the life of  $J = 0$ ."

Now we may take it that the fire offices are quite as anxious as the contractors to see one set of rules adopted, and, generally speaking, they will not care from whence they may emanate, so long as they fulfil certain conditions. No one wishes to deprive the "Phoenix" of the credit due to them in the matter, indeed, that would be impossible; but we and others have objected to Mr. Heaphy's rules as unsuitable from a business point of view, on account of their vagueness in important points, leading to unnecessary correspondence and interviews.

A very laudable attempt was made last year by the Fire Offices' Committee to issue an official set of rules which, we believe, would have given satisfaction to all concerned, but owing to the factious opposition of a few, it was deemed advisable to let the matter rest for a time, and thus we have drifted into the present unsatisfactory state of things.

Now as to an ideal set of rules. Let us consider them from the fire office point of view. In the majority of fire offices the inspection of electric installations forms but a small portion of the duties of their surveyors, and it is essential that that portion be rendered as light as possible. Hence rules regulating the installation of electrical energy should be definite and precise—in fact, in the form of *must be*, and not *should be*. Limits as to current, spacings, insulation, and the like, should be all clearly defined. Nothing should be left for "approval," and the "inspector" should be eliminated from them. It is quite possible, in our opinion, to draw up a set of rules that shall compel good work, without entering into minute details. Specify for enough copper, well insulated, and the proper jointing and carrying of conductors; state the principles governing the construction and mounting of switches and cut-outs; prohibit their being placed in positions where, if they go wrong, they can do harm; then, if the total insulation of an installation is satisfactory, we may rest content. Above all, do not harass the contractor with mere fads and fancies. Reasonable security against fire can be attained without unnecessarily adding to the cost of wiring, and thus retarding the more general introduction of what is, after all, the safest light to be had.

The insurance companies' task will in future be much simplified by the Board of Trade regulations. They need now concern themselves only with the house work. More latitude should be allowed in wiring off a direct continuous current supply, as against alternating transformer systems. With the former one well-known company had no trouble, whereas with the latter it has had a good deal.

The present agitation will do good, and we hope lead to some satisfactory results this autumn. Upon one thing, however, everybody concerned may rely. The leading fire offices will not have the Phoenix rules thrust upon them in their present garb—Prof. S. Thompson notwithstanding! Let that be clearly understood.

To bring the matter officially before the representatives of the fire offices, we would suggest a letter on the subject being addressed to the Secretary of the Fire Offices' Committee, Watling Street, from, let us say, the Electrical Section of the London Chamber of Commerce?

There is no need to trouble the Institution of Electrical Engineers further; there are certain broad principles common to all systems of electric lighting, but we feel inclined to agree with a gas contemporary that electricians will have to share the fate of gasfitters in a similar event, and meet every fresh case on its own merits. It cannot be a difficult task to settle the principal desiderata of safe electric light wiring; but exceptional cases are certain to arise from time to time, which cannot be dealt with by hard-and-fast rules. The project of employing the Institution of Electrical Engineers, or the Board of Trade, or any other outside body to draw up a code of fire rules, falls to the ground the moment it is perceived that since the Fire Offices would have to pay the damage, they must have the last word as to what precautions they would be satisfied with before issuing a policy.

A last word on the duties of inspectors. Can it be a satisfactory condition of affairs to know that the representative of a fire office may also be a consulting engineer even if he has no direct interest in any electrical supplies? We believe the inspectors of Lloyd's, for instance, devote the whole of their time to the duty of examining ships, and do not practise as technical advisers to the very people with whose vessels they may have to find fault. In electrical engineering, however, possibly because the business is yet but in its infancy, we have known instances of fire inspectors acting as censors of the work and materials advised by them, as experts, to be employed; and consulting engineers acting as contractors to their own clients; in fact, as they cannot fill up their time profitably in one branch, there is a tendency to combine all. These things should not be passed unnoticed, and the pages of the REVIEW are open to any of our correspondents to suggest plans by which the whole fraternity may yet become a happy family.

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Refusal of a  
Concession for  
Electric Tramway.

THE Thomson-Houston Company has experienced a rebuff on the part of the Bremen Town Council. One of the reasons assigned for the refusal of the concession

for a projected line from the Rathhaus to the Buergerpark was said to be due to the very unsatisfactory working of the electric tramway at the Bremen Exhibition. The noise occasioned by the cars was considered unbearable, and another objection was raised against the sparks or "flashes of lightning" between the wheels and rails forming the return circuit. Similar complaints reach us from Italy anent another American system, and it appears that people on the Continent of Europe are not inclined to put up with nuisances which our American cousins tolerate. Toothed wheel gearing must sooner or later develop that rattling noise which, however natural to a machine shop, will never be appreciated in a public conveyance. Visitors to Blackpool are ever complaining of the noise occasioned by the electric trams, and these are fitted with the best kind of chain gearing, as are also those of Barking Road, with another noisy sort.

**The Oldest Electric Tramway.**  
THE Lichterfelde Electric Railway, the oldest in the world, has been extended to the Potsdam Railway station and opened for traffic.

**Duty on Electricity.**  
AMERICANS, more than any other nation, enjoy the privilege of paying duty for most things which cross their frontier. Hitherto electricity by means of submarine cables has entered free of duty; this was for telegraphic purposes only, but the probability is that this "imponderable matter" may, in future, be taxed if "imported" for other uses. There exists, according to the *New York Herald*, an enterprise called the "Cataract Construction Company," which has for its object the utilisation of the power of the Niagara Falls. This company having learnt that some Canadian parties are endeavouring to organise opposition for the construction of works on the Canadian side, with the intention of transmitting the power to the American side, have asked the Conference Committee on the Tariff Bill to insert a clause taxing the conveyed energy at the rate of \$5 per horsepower. It is not stated whether this is for a horsepower per minute or per annum; anyhow, the question is an interesting one, and we wonder whether the vigilant U.S. Custom House officials will stop the current at the frontier for the purpose of examining its *quality*, since the notion of two kinds of electricity still exists in certain quarters, or whether it will be passed through a meter kept by the excise officers?

**Paper Tubes for Underground Work.**  
PIPES for gas, water and electric cables, made of paper, have recently been exhibited in Vienna. The width of the paper is equal to the length of a given pipe. The paper runs first through molten asphalt and is rolled upon a mandril of wood, the size of which determines the inside diameter of the pipe. When cool, the mandril is removed, and the inside of the tube covered with a kind of enamel, the composition of which is kept secret. The outside is covered with a bituminous lacquer and sand. It is stated that a pipe of 2 centimetres thickness of material stands an internal pressure of 1,000 kilogrammes.

**Curious Reasoning.**  
AN electrical contemporary which, last week, devoted a leader to prophesying the speedy demolition of the B.A. for the Advancement of Science, unless reforms were adopted to meet the wants of the times, commences in the following contradictory manner:—"The afternoon of

Saturday was very fine in Yorkshire; and the meeting of the British Association may therefore be considered to be a success, since members had every opportunity for enjoyable excursions." Just as one swallow makes a summer, so a fine Saturday half-holiday sets the seal of success upon what the *Evening News and Post* calls a moribund association.

**Delay in Applying the Telegraph Scheme.**  
WE have already laid the general terms of the new telegraph scheme before our readers. Though some months have elapsed since its existence was made public, it is surprising to hear that it is not yet in general operation at the Central Telegraph Office. Whatever may have led to this extraordinary delay, it is to be hoped that such points as a fairer system of awarding sick pay to first and second class clerks, the question of a month's annual leave to the former body, and the unsettled question of the improvement of the position of senior clerks, will have been found to have received that full measure of recognition which their importance demand.

**Elmore's French Patent Copper Depositing Co., Ltd.**  
A FINANCIAL contemporary writing on this subject makes the following apposite remarks:—"The game that has been played is undoubtedly a clever one, but its success does not inspire us with confidence in the future of the companies. The mere fact that each parent concern has created sub-companies, and received substantial sums from them is sufficient explanation of the premium at which the shares of each of those concerns stand, but what has any one of them *earned*, and what have the off-shoots accomplished in the way of genuine business? It stands to reason that these fresh issues of capital cannot go on for ever. The time must come when the *bonâ fides* of each of them, and the commercial value of the Elmore process will be put to the proof, and it is our duty to keep this fact before our readers. Our own opinion is that the invention of the Messrs. Elmore is worth money, but not so much money as the wire pullers have obtained for it; not as many pence as they have been paid shillings, and we do not for one moment believe that the demand for absolutely pure copper is sufficient to return a dividend of 1 per cent. upon the capitalisation of the companies we have enumerated. Were there but one—Elmore's Patent Copper Depositing Company, for instance—it might be a pronounced success; but as it is, we feel convinced the result will be a disastrous one for the shareholders. It must be remembered that the aggregate capital employed is £820,020, made up as follows:—

Elmore's Foreign and Colonial	...	...	£120,000
" Copper Depositing	...	...	200,000
" Wire Manufacturing	...	...	300,020
" French Patent	...	...	200,000
			£820,020

To pay 10 per cent. upon that amount will require £82,000 per annum." It is possible, however, that Sir W. Thomson's paper to which we alluded last week on p. 287, may create a great demand for perfectly pure copper.

**Accumulator Trams.**  
How is it that with twelve cars the Birmingham Central Tramways Company run only five of them? Also how is it that the General Electric Power and Traction Company, with six cars at Barking Road, have only three and sometimes only two running?

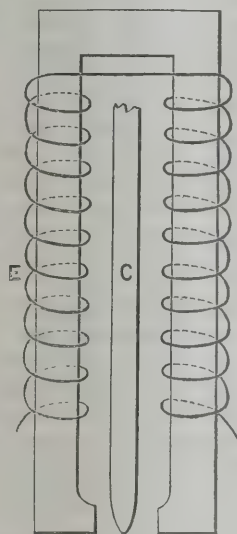
## ELECTRIC BLOW-PIPES.

By A. M. TANNER.

MY attention has been drawn to an illustrated article in the *Electrical World* of August 23rd, 1890, on welding with the electric arc. This article reviews certain inventions of C. L. Coffin on the above-entitled subject, and says that "the fundamental principle involved therein can be called that of an electrical blow-pipe;" furthermore, it is stated that the idea of handling the electric arc as one would a blow-pipe with a magnetic blast instead air, is certainly a very beautiful and ingenious application of theory. From this it would appear that Mr. Coffin, or the writer of the article in the aforesaid journal, is without knowledge of the electric blow-pipes of Werdermann and Jamin, and the fact that the action of electro-magnets upon the electric arc has frequently been studied, notably, by Quet (see *Comptes Rendus*, of French Academy of Sciences, Vol. XXXIV., A.D. 1852, page 805). Quet states that Davy was the first to experiment upon the voltaic arc with magnets, and that Despretz and others had also studied the same phenomenon. In referring to his own experiments, he says:—

"I caused a very powerful electro-magnet, made by Rhumkorff, to act upon the Davy arc, and I transformed the column of light into a long rushing point of an intense heat, and similar to the blow-pipe flame. I obtained this result by placing the carbons perpendicularly to the common axis of the electro-magnet coils. In order to explain my idea, I will suppose this axis to be horizontal, the carbons vertical, and their points placed between the neighbouring poles of the apparatus. In these conditions, instead of a vertical column of electric light a horizontal point is formed (dard) perpendicularly to the axis of the coils, just as when the blast of a blow-pipe is directed upon a flame. The analogy is so complete that, by reason of the noise produced by the arc, it appears as if some one were blowing. The light of this point has neither the whiteness or dazzling character of the electric column it displaces; nevertheless, its heat is very great, because it is capable of melting platinum. Because of this last-mentioned property, and the form taken by the arc, it appears to me that this kind of *electro-magnetic blow-pipe* can be usefully applied in the arts. The electric point (*dard électrique*) is remarkable for its length. In my experiments, it was eight or ten times more than the maximum length of the luminous column. Quet also states that the carbons can be placed at an angle, or one at the side of the other, in which case the electric point is formed laterally and parallel to the carbons. It will readily be perceived that Quet foreshadowed Coffin's process, in which the arc is formed between two converging carbon pencils and is blown downward upon the metal surfaces to be heated by the influence of an electro-magnet. An arrangement of parallel carbon electrodes (as in Jablokoff candle) and electro-magnet is shown by Richard Werdermann in his English patent, No. 1,438, dated April 24th, 1874, for a method of cutting rock or stone, &c. I can do no better than to quote the entire description of this patent, bearing upon an electric blow-pipe, particularly as the article on Coffin's welding process states that an air-blast is sometimes used for deflecting the arc. This is also an idea disclosed by Werdermann, as will be seen from the following abstract of the description found in the patent, viz.:—"When the rock is very hard, as porphyry, granite, gneiss, and the like, I prefer to use an electric blow-pipe. Fig. 3 is a plan of an apparatus for carrying this part of my invention into effect, and fig. 4 is a front view of the same. In this apparatus the carbon points, *g*, of the electric light are fixed on a suitable handle or frame provided with pinions, *h*, and racks, *h*<sup>1</sup>, to regulate their distance. I blow through the voltaic arc over the two carbon points, *g*, a powerful current of air or steam or other suitable vapour or gas. For this purpose I provide a carbon tube, *k*, arranged over the said

carbon points, *g*, and provided with an adjusting pinion, *l*, and rack, *l*<sup>1</sup>. The air, steam, or gas is supplied to the said carbon tube by a pipe, *m*. When the blast is in operation through this tube, and the light is burning, the flame of the voltaic arc will produce the effect of a powerful blow-pipe. *g*<sup>1</sup>, *g*<sup>2</sup>, are wires connecting the carbon points with a battery. In fig. 5 I have shown an apparatus in which the carbon points are arranged between the two poles of a powerful electro-magnet, and the blow-pipe is not used. As soon as the light is produced and the electro-magnet set in action, the voltaic arc is repelled and pointed like the flame of a blow-pipe. The heat obtained by the apparatus shown in figs. 3 or 5 is so intense that the hardest granite is thereby not only calcined but is fused in a few seconds."



E, Electro-magnet. C, Carbon pencil.

FIG. 5.

Another electric blow-pipe (*chalumeau électrique*) is described by Jamin in the *Comptes Rendus* of the French Academy of Sciences, Vol. 88, A.D. 1879, page 544. After having described an electric lamp with parallel carbons, and the effect of an electro-magnet upon the electric arc, first discovered by Quet, Jamin states:—"The fusion of lime proves that the arc thus projected by a magnetic effect is capable of considerably heating all bodies; it is a genuine blow-pipe, and probably the most powerful of all. I recommend it to chemists and physicists."

The blow-pipes of Werdermann and Jamin, although not specially designed for such purpose, are adapted to be used for the electric welding of metals, since they have parallel electrodes arranged in such a way that the arc can be projected upon surfaces placed beneath the arc. There is another more recent reference to be considered which is also an electric blow-pipe, and is specially designed for welding and soldering metals. The English patent of Bernardos and Olszewski, dated October 28th, 1885, No. 12,984, describes and illustrates in figure 35, an "Electric Solderer," which has two parallel carbon pencils fastened in a holder and arranged above an anvil on which the work is placed. The anvil is surrounded by a wire coil, so that when the electric current produces the arc between the parallel carbons and flows through the anvil coil, the anvil is converted into an electro magnet "whereby the flame of the arc is drawn to the object to be operated upon."

I think I have satisfactorily shown that Mr. Coffin did not invent the electric blow-pipe. Quet having fused platinum with a so-called "electro magnetic blow-pipe" in 1852, and Werdermann having subsequently applied the same instrument to the cutting and fusion of mineral substances. Du Moncel, the eminent historiographer of the applications of electricity, says in his work: "I desire to be impartial in my

writings and 'à rendre à César ce qui appartient à César.' It is well that this should be observed in this modern age of electricity, and credit bestowed where credit is due.

### MUNICIPAL LIGHTING.\*

By M. J. FRANCISCO.

THE electric spark that Franklin gathered upon his key lay dormant for years, until from the fires of genius, guided by the finger of science, there flashed forth the electric light. This has been increased and magnified, until to-day America stands as the exponent of this science, with 300,000 arc and 4,000,000 incandescent lamps flashing like meteors across the continent. Thus has science aided nature in lighting up the streets and highways of our native land, from the shores of the Atlantic, across the snowy peaks of the Rocky Mountains, to the golden shores of the Pacific.

This vast industry, requiring an army of over 300,000 men and an investment of \$300,000,000, is the result of American genius and enterprise. Truly we may well congratulate ourselves that we are here to-day as the representatives of this science and industry, which is revolutionising the world. Not only has the globe been encircled with telegraph symbols, and the human voice sent flying across space for thousands of miles, but the ocean itself has been studded with electric lights, guiding the mariner across its waste of waters, and flashing its brilliant hues as a welcome beacon upon the weary eyes of many a watching crew, whose vessel was sinking in mid-ocean.

This science, fraught with so much good for mankind, which has put millions of money into circulation and furnished employment to thousands of labouring men and others, is now menaced by men who, posing as economists, desire to use this power for political and other purposes, as well as for their own aggrandisement, regardless of the interest of the masses or the public welfare. The plain English of this movement is municipal control of electric lighting plants.

Who are the great apostles of municipal ownership of electric lighting plants, claiming that municipalities can furnish lights cheaper than private corporations? Mostly visionary, theoretical dreamers. Not one has had a single day's practical experience in the electric lighting business. For example we were treated to a specious article in the *New York Independent*, purporting to come from a professor of Johns Hopkins University. An examination of the article shows at once that the author has no experience or practical knowledge of the business, and proves to be simply a youth from Omaha, Neb., who has been studying there for a couple of years. He is now told to cry monopoly, and this article is the result. These are the persons who are being used by professed economists, wire-pullers, and others as figure-heads; who make statements based upon a state of things that do not exist, and use such statements in contradiction of the actual experience of practical men and the best scientists of this generation, who have not only made the subject a study, but demonstrated the same by testing it every night for years.

If a municipality can sell electricity cheaper than private corporations, why should they not manage all other industries and trades of the country? All cities have large amounts of printing done; why not have the city own and run paper mills and printing offices? also street cars, and own mines and sell coal? They also use immense quantities of stone, building material, &c.; then have them run a marble quarry. The taxpayers use carriages; let the city build these also. And so on with every industry requiring the investment of private capital. If municipalities can save the taxpayer

money in controlling and manipulating one industry, why not all? If they can do it cheaper, then every taxpayer would receive the same proportional benefit as is claimed for electric lights.

The great argument used in support of municipal control of lighting plants is a list of cities, with what purports to be accounts of the cost of their electric lights, where over half of the expense of the lights has been charged to other departments. Among these are Bay City, Bangor, Dunkirk, Chicago, Ypsilanti, Topeka and Lewiston.

We will examine a few of the claims made as to the cost of lights in these cities.

The City Superintendent of Bay City, Mich., reported that the cost of the electric lights was only \$40 per year. The Council of Bay City appointed a special committee to investigate the expense of city lights, and they submitted a report showing that the city was running 137 lights at a cost of \$59.42 each per year, not including taxes, water rates, interest or depreciation. Including interest, 5 per cent. on \$35,000, cost of plant, taxes and water rates,  $2\frac{1}{2}$  per cent., 10 per cent. depreciation, the cost was \$104 per year each lamp, running only dark nights. A short time since, during a thunder shower, the city was left in darkness, because the City Superintendent was afraid of burning out an armature if he ran the lights. A gentleman passing an evening in Bay City recently inquired why they did not have street lights, and the answer was "We do have them," and sure enough, at nine o'clock, they started the lights. Still, the price charged by electric light companies for first-class service, with lights every night, even when obliged to compete with the rival forces of Heaven's batteries, is compared with such service as shown in Bay City.

The city of Bangor claims that the average cost of burning a light each night is  $12\frac{3}{4}$  cent.; that is \$46.23 per year for each lamp. The electrician is paid \$78.50 per month, or \$942 per year; his assistant receives \$520 per year; one lineman is employed at \$624 per year; two trimmers at \$1,248 for the year—making \$3,334 for wages of these men, being \$22.82 per lamp per year. They run all night, requiring double lamps and four carbons for each and every day, calling for 1,460 carbons per year each lamp; for these they pay \$13 per thousand, and in addition pay 96 cents. per thousand for freight and 5 cents. per thousand for cartage from the freight-house, making cost of carbons \$14 per thousand, or \$20.44 per lamp per year. Allowing \$2.97 per year for oil and waste, we find the amount paid by the city for wages, carbons, oil and waste was \$46.23 per lamp per year. This is  $12\frac{3}{4}$  cents. per lamp per night, just what is claimed as the entire cost to the city for running their lights. The plant cost \$35,000, and this does not include anything for the water-power nor for any portion of construction of the dam or cost of its maintenance, or for the station buildings. Interest on \$35,000 at 6 per cent., \$2,100; depreciation on electric apparatus, 10 per cent., \$3,500; broken globes during the year, \$130; wall controller burned out, costing \$160; 15 lamps broken, repairs costing about \$300; damage to mast-arms, repairs costing \$100; repairs at station, \$500; also \$730 paid for coal. Here is \$7,520, which is part of the expense of the electric lights charged to some other department, while to get the true cost there must be added to this the repairs to the dam, interest on the cost of the buildings, wages of an engineer when engine is used, cost of new brushes and segments; also taxes and water rent, which the city would receive from a private corporation if running the lights, which, at the lowest estimate, would be over \$1,000 per year; thus making a total cost to the city of \$15,271.86 for running 146 lamps one year, being \$104.59 per lamp, and that, too, with water power all the time except for about six weeks.

The favourite place quoted by advocates of municipal ownership is Dunkirk, N.Y. I herewith give the report of the water commissioners of Dunkirk. As a specimen of expert bookkeeping, and a sample of the way accounts are kept by cities, I recommend the plan

\* A paper read before the American National Electric Light Association, August 20th, 1890.

to all electric light men ; for, if you are endeavouring to satisfy your constituents or stockholders that electric lights can be run without money and without price, it cannot be excelled. The report reads as follows :—

“PAID ON ACCOUNT OF ELECTRIC LIGHT.

For linemen's salary ... ..	\$540.00
For fuel ... ..	933.24
For supplies ... ..	447.60
For labour repairing line ... ..	41.42
For repairs on engine and boiler ... ..	65.64
For repairs on machinery ... ..	99.40
For miscellaneous accounts ... ..	14.60
	<hr/>
	\$2,141.90

“The above statement shows very distinctly that the most sanguine predictions as to the cost of running the electric lights of this city have been more than realised. After a trial of one year and eight months, the machinery and line are in better and more perfect condition than when first started. The cost of our electric light does not exceed 1 cent per hour for each light.”

Here we have a report from the city authorities stating that the entire cost to the city of running 55 arc lights one year was \$2,141.90.

You will notice one item is repairs on engine and boiler ; also one item for fuel, showing that the plant was steam power, and, what is far better, a style of boilers and engine that ran the entire year, starting and stopping at proper times automatically, without anyone to look after them except a man occasionally to make a few repairs—the coal walked into the furnace without assistance, and no one was employed in or about the station, neither did the plant cost the city anything.

Here is a sample of the reports made by politicians and those professed economists, which shows just how reliable they are. Of course, a man of practical experience, and knowing that electric lights do not run without human agency, would look further before accepting such a statement ; and when we examine the accounts of the water-works, we find engineers and firemen paid \$3,555, supplies \$449, general expenses under superintendent \$995, miscellaneous accounts \$240, superintendent's salary \$720, interest on bonds \$7,025—making \$12,984 additional. Even if only one-third of this is charged to electric lights, we have \$4,328 to add to the \$2,141, making \$6,469 for 55 lights, or \$117 each per year. Consistency, thou art a jewel !

Chicago, it is claimed, is the centre of the world, and the only place on this mundane sphere where mortals can be happy, and where life can be spent without thought of money or the hereafter, because their electric lights only cost \$73 per year. We admit that Chicago has triumphantly secured the World's Fair, and is now transposing our national air to “Hail, Chicago ! happy land.” But they have not yet seen the bills for the electric lights, as furnished by the city and used on that occasion. When they do, the city electrician will need to add something more to his stereotyped answers that the cost of city lights “does not include any expenses such as you mention—taxes, water rent, interest on investment, insurance, repairs, depreciation or renewal of plant in general ;” neither will it be expedient to charge the wages of the electric light linemen to the fire alarm telegraph department, notwithstanding it works very nicely now, and helps wonderfully to make the cost of an arc light appear small.

Upon investigation of one of their stations of 275 to 300-light capacity, I find that the chief engineer receives \$1,200 ; assistant, \$1,030 ; four firemen, \$2,880 ; six trimmers, \$3,240 ; line tester, \$720 ; three linemen, \$2,520 ; cost of carbons, \$3,800 ; fuel, \$12,000 ; interest, \$14,000 ; depreciation, 2½ per cent., \$8,750 ; oil, waste, repairs, globes, taxes, &c., \$7,000—making \$57,190 a year expense for running 300 arc lamps, being \$190.63 per year per lamp, and this makes no provision for salary of electrician, superintendent, or for armatures burned out, or any accidents or

damages. With the linemen's wages charged to the fire alarm telegraph department, we can reduce this \$2,520. Now, to what other department do they charge the other expenses to reduce it to \$73 per year per lamp.

Ypsilanti, Mich., is the Mecca toward which all advocates of municipal ownership turn their longing eyes, and we are informed that the entire cost of a 2,000 C.P. lamp is \$23.61 per year, when the truth discloses the fact that Ypsilanti pays \$72 per year, only running 18 nights a month until midnight. Wishing to have the views of the prominent authorities of this wonderfully-managed city, the following questions were propounded, and I give both the questions and answers :—

Q. 1.—With your experience, are you in favour of cities doing their own lighting ?—A. No.

Q. 2.—Why ? A.—Political preferences and frequent changes of management are too expensive. Incompetent engineers, linemen, and trimmers kept in place by a committee for political or other purposes ; poor carbons, lack of attention generally, grounding of wires, breaking of globes, infringement of patents, constant repairs, &c., make this system expensive and an unknown amount till the year expires. *The wear and tear is immense*, all kinds of complaints and no responsible head is the rule. On the contract plan for light you pay for what you get only, and know what to provide for in the estimate for tax levy.

Q. 3.—If your city had the work to do over again, do you think they would do the same ?—A. No.

Q. 4.—Has the municipal operation of your plant met all expectations and requirements ?—A. No.

Topeka is another place where electric lights furnished by the city are cheaper than sunlight, and the city jubilant over their purchase. I quote from a letter written by a prominent official of the City of Topeka, which seems to prove that their millenium has not yet arrived. He says : “The agreement for all night lighting was \$6 per light per month. We find that the cost of operating the plant of 184 lights for all night has been \$11 per month. The agreement further provided that lights should be 2,000 candle-power ; all the tests we have made do not show them to be over 500 candle-power. Our lights so far have been very unsatisfactory. My own opinion of the matter is that it would be much cheaper in the end for the city to have contracted with some of our electric light companies here to furnish the city with its lights at so much per light. We would then have known at least just what they would have cost. As it is, we have to take our medicine, which is liable to be a very expensive dose. It is a very expensive luxury, and there are so many expenses coming up that we cannot foresee ; therefore, I say, when you take everything into consideration—interest on the investment, wear and tear on machinery, dynamos, &c. (the contractors are already building over ours, and they have not run two years yet)—consider well before contracting for a plant.” Here is the opinion of an honest official, who has had experience with a city owning a plant.

Lewiston, Maine, is another brilliant example of municipal ownership. They have a plant of 100 arc lights, which cost the city \$15,000. They burn, on an average, 24 nights per month on moonlight schedule, and the Mayor says the actual running expenses are \$4,200 per year. Add interest on cost of plant, depreciation, 5 per cent., taxes, rent of water-power, which the city would have received from a private company ; therefore it is costing the city for 100 arc lights, using water-power, \$7,200, or \$72 per lamp per year, while the local electric light company offered to furnish the same lights for \$5,760, being \$1,440 less than it costs the city to run their own lights ; and still it has been advertised broadcast that the cost of arc lights in Lewiston was only 14 cents. per night.

I have secured reports from fifty municipal plants, embracing nearly all the cities and towns in the United States owning plants, and find that the cost of these has been \$1,511,225 ; that they are using 3,725 lamps ; 12 places running all night, and 38 until midnight or

on the moonlight schedule ; that the average price paid for coal is \$2.34 per ton ; that the actual running expenses have been \$251,194 ; that the interest on the cost of these plants is \$90,691 ; depreciation at 5 per cent. \$75,576 ; cost of replacing armatures actually burned out, \$12,000 ; taxes city would have received from private corporations if they had furnished the lights, \$15,715—making the total expense to these 50 cities of burning 3,725 lamps (two-thirds of them only until midnight) for one year \$444,486, or an average cost of \$119.24 per lamp per year. In the figures going to make up the cost of plants and the running expenses I have taken the statements and amounts as given by the city officials, but when we are told that the total amount paid for a complete plant of 68 arc lamps, with engines, boilers, dynamos, &c., was only \$1,300, and informed that the total running expenses of a plant that cost \$12,000 are only \$1,100, and in the same communication the statement is made that they pay their engineer and linemen \$125 per month, making annual bill for these men's wages of \$1,500, we naturally long for the secret which enables them to settle this amount and pay for repairs, oil, coal and other expenses with an expenditure of only \$1,100.

I have statistics from 365 electric light companies furnishing 35,100 arc lamps for street lighting, three-fifths burning their lights all night, and two-fifths burning until midnight, or on the moonlight schedule. The average cost of coal is \$2.76 per ton. The average price charged per lamp for street lights is \$118 per year. This is the price when furnished by electric light companies, who have assumed all the risks and liabilities incurred in the business, and who must furnish first-class lights. This is the cost with lights burning every night without a break, as the contract calls for, and necessitating a rebate if lights are out, which would reduce the price paid by the city.

Only one-third of the cities owning plants run them all night, while of street lights furnished by private companies three-fifths burn all night. Lamps all night and every night would burn 4,000 hours per lamp, while the moonlight schedule would only require about 2,100 hours per lamp. The cost to companies, of course, is much more for all night lights than it is until midnight, and had lights run by municipal plants been burned the same length of time as lamps furnished by private corporations the average cost would have been still more, as lights must have burned about twice as many hours.

It will be noticed that the average cost of coal used by municipal plants was \$2.34 per ton, owing to the fact that the majority were located near the mines or places where coal was cheap, and the average as shown for electric light companies is \$2.76 per ton, owing to the fact that coal was transported long distances, at high rates of freight. Even with this factor against them, it shows conclusively that private corporations are furnishing cities with lights for less money than they can themselves produce them while owning the plant. This, too, with the expense of operating city plants figured as given by the various cities, which their own report shows is incorrect, and less than actually paid.

It is well known that if a private corporation is furnishing municipal lights, when they are out for a short time or are not up to standard, a rebate has to be made, amounting in the aggregate to many thousands of dollars ; but you will never see this item deducted when advocates of municipal control are quoting the cost of lights. Neither do they allow the fact of the city's liability for damages and accidents to be developed. If the municipality own the plant they assume these chances, and here is a feature of responsibility which in most States rests upon the individual as well as the city. The property of any citizen can be held for an execution against the town for injuries caused by a municipal plant, no matter if it amounts to thousands of dollars, and thus he might be deprived of his most valuable personal rights and liberties. If electric light companies furnish the lights, they must meet such claims and protect the city from loss, and

the court records show that electric light companies have paid heavy damages on this account.

In the reports received from city officials regarding the cost and operation of their lights, one says : "No expenses charged to lighting account." Again : "Lights are not started for an hour after dark." Many say : "Whenever a thunderstorm approaches, lights are shut down and city left in darkness." Another says : "Have not had lights for past two weeks, owing to some trouble at station ;" while many report wages of *employés* charged to water department, and others that no account of lighting expenses is kept. Here we have the basis upon which reports are made that the cost to cities owning plants is so much less than it is when private corporations furnish them, simply deceiving the taxpayers by charging part of the cost to other departments, while raising a hue-and-cry about the extortion of electric light companies.

No sane or fair-minded man will, with the corruption and fraud practised by politicians at the present day, attempt to prove that it is for the best interest of the taxpayer to place faith in the honest or conservative management of any enterprise which can be manipulated in the political arena for the advancement of the men in power. The histories of New York, Philadelphia and many other cities are samples of such methods and their purifying effects upon politics. Hypothesis and theory may do on paper, but actual results obtained by practical application and experience are the only reliable data upon which to base any statement relating to the cost of street lighting. In every case these have shown, where all the facts are given, that it has been for the best interest of the citizens and taxpayers to contract with an electric light company for lighting the streets of any city.

Many cities have found by actual experience, after spending a large amount of money, that this is a fact. The City of Greenville, S.C., has sold out its municipal electric lighting station, the purchasers agreeing to relieve the city of all pending liabilities in connection with the light plant. The city has agreed to pay \$100 per year per lamp for not less than 40 ; the agreement to run for 15 years. Negotiations are pending in several other cities for a sale of their plants to the local or private electric lighting company, as they have found that it was impossible to produce the light, when managed by politicians with no interest in the business, as cheaply as could be done by a private corporation whose managers were financially interested in its success.

There is another feature of this business that it is well to consider. Under the authority and sanction of the Legislatures of the States, private capital amounting to millions of dollars has been invested in the enterprise of electric lighting. The benefit that municipalities have received from this capital is enormous, and it is a question whether the private capital thus locally invested under the sanction of the State can be jeopardised and endangered by the action of municipalities, who are subject to and under the control of the State. In England this matter is fully settled, and no municipality can operate its own plant, if by so doing it will interfere with any local or private company authorised by Parliament.

Judging the future by the past, with the mighty strides that have been made in electrical inventions, two years from now the entire apparatus at present owned by municipalities may be consigned to the scrap pile, and necessitate a new outfit costing thousands of dollars. What is to be done in this case ? Levy another tax or issue more bonds, and thus load the city with more debts. Electric light companies have already had this experience, and I can cite a case where the company paid \$4,500 for their dynamos, and, after a little over two years, could only realise \$300 from those same machines. Why is this ? Simply that improved plans and apparatus have been discovered which reduces the cost of producing electricity, and unless companies can control these new patents they will be stranded in the race of invention.

Consider, then, for one moment the effect upon the

business world if to-day it were possible to blot out electricity and electric lights, with all their conveniences, comforts and luxuries; to stop the progress and development of this wonderful science, and shroud America in a gloom that could only be expressed by Byron when he "had a dream which was not all a dream," and

"The bright sun was extinguished,  
And morn came and went—and came—and brought no day,  
And all hearts were chilled into a selfish prayer for light.  
The rivers, lakes and ocean all stood still,  
And the clouds perished. Darkness had no need  
Of aid from them—she was the Universe."

### THE RELATIVE COST OF GAS AND ELECTRICITY IN COTTON MILLS.

WHEN it is attempted to draw comparisons between gas and electricity and their relative cost, it is not unusual to estimate the former by simply referring to the actual cost of the gas consumed as registered by the meter, whilst the cost of an electric light is obtained after every possible charge has been put down to its account. Such a result not infrequently places the electric light at a serious disadvantage from the economical point of view.

But an estimate of this character is far too one-sided to give a true statement of the case. Those who are interested in the electrical industry do not object in the least to have the electric light properly debited with all the incidental and necessary items, but they do naturally object that, on the gas side, all the incidental items, save that of actual consumption, should be omitted. Neither is it fair altogether to omit from these calculations the relative benefits, or otherwise, derived from the use of the two illuminants.

As we have remarked, an electric light installation is debited with all its charges to the capital account, and in its maintenance not only is the depreciation of the plant considered, but every item due to repairs, wages, &c., is fully considered and provided for.

On the gas side, however, no such items are usually taken into account; but, dealing with the gas question in a large mill or manufactory, there are a number of expenses necessarily entailed, which should certainly be taken into account when a perfectly true and reliable comparison is desired. For instance, the installation of a gas plant of 1,000 or more lights into a large mill entails the expenditure of a considerable amount of capital, although it is known that a gas plant can be put in at the present time for a very small sum. There are, however, many mills where the capital expended upon the gas installation has cost 20s. per light, whilst at the present time they can be installed for as low as 5s. or 6s. per jet. Still, this requires some capital, and, necessarily, should be subject to some charge for depreciation. The lighting up of a large mill, and the extinguishing of these lights requires a considerable amount of labour and time. The value of wages taken up per annum in this alone is a serious item, but it does not count. It will be found that where there are a large number of lights in use there is almost always a "gasman" employed in looking after the fittings, and keeping everything in proper repair; but his wages are not counted, nor are the various items which usually come under the head of repairs, for it is impossible to conceive that gas-pipes and fixtures are never out of order.

When the relative charges are properly considered, a more reliable estimate can therefore be obtained; but there are circumstances which prevent such a comparison from being made; this is owing to the fact that it is very rare for the cost of the maintenance of an electric light installation to be kept. We are aware, however, of several cases where this has been done, and we have had the following statement presented to us for publication, which gives the information in a comparative form, prepared by the proprietors of some very

large mills in the neighbourhood of Manchester. These results give the relative cost of gas and electricity for a period of six years, taken from the actual working experience of one of the company's mills at Mosesgate, near Bolton. The statement is given exactly as handed to us.

HORROCKS, CREWDSON & CO., LIMITED, BOLTON.

*Gas v. Electricity at Mosesgate.*

SIX YEARS TO DECEMBER 31st, 1889.

	£	s.	d.
826 gas lights, cost for piping, meter, &c. ...	215	2	2
Depreciation at 5 per cent. per annum—6 years =			
£73 12s. 11d.; or, per annum ...	12	5	6
Average gas account, per annum ...	217	11	3
	826/229	16	9
Cost of gas per light per annum ...	0	5	6½
Electric installation (263 lamps) cost, including gear- ing, belting, &c. ...	410	17	9
Depreciation at 7½ per cent. per annum, 6 years ...	153	10	1
Renewal of lamps, repairs, &c. ...	101	11	4
Power estimated at 30 I.H.P. at £5 = £150.			
Depreciation on £150 for 6 years, at 5 per cent. per annum ...	39	14	4
Coal at 3·7 lb. per I.H.P. per hour (275 hours per ann.), for six years at 6s. per ton ...	22	2	0
	6/316	17	9
Cost per annum ...	263/	52	16 3½
Cost per lamp per annum ...	0	4	0½

Cost per light per annum—Gas, 5s. 6½d. — Electricity, 4s. 0½d.

Gas costs 38·34 per cent. more per light, and (as one electric light displaces two gas lights in weaving shed), gas costs 176·68 per cent more per loom.

It will be observed that, in the foregoing statement, the gas account is simply debited with the average gas consumption and a depreciation charge of 5 per cent. upon the original cost, nothing being allowed for repairs and such other charges as we have previously mentioned.

The account for the electric installation of 263 lights includes dynamos and everything that is necessary to a complete plant. The work in this case was satisfactorily done by the Manchester Edison-Swan Company, Limited, and it is gratifying to notice here that, throughout the six years, the working has been of a satisfactory character. The charge for depreciation is 7½ per cent., or one-half more than in the case of gas. The power of the steam engine is estimated at 30 I.H.P., that being the proportion of the main engine of the mill, utilised for the purpose of driving the dynamo. Tests subsequently made showed that the actual I.H.P. utilised was only 27 H.P., and at this figure the coal consumption has been calculated. The item for repairs, &c., includes the cost of oil and sundries, besides lamp renewals. It will therefore be seen that full charges have been debited to the electric light account. It may probably be remarked that no charge has been made on account of wages, but as the engineer in charge of the engines has done this small amount of work as part of his ordinary duty, no charge has been made, for no extra expense has been incurred.

Under these circumstances, the electric light shows a very distinct economy over gas, and it must be acknowledged that, in the case of a weaving shed, the result is very remarkable.

The present is a case where the mill engines have had their surplus power utilised in favour of the electric light installation, a case by no means unusual, and one which would undoubtedly be more frequently adopted if mill-owners were more alive to this fact. In a very large number of instances, the power required for the electric light has been in excess of that which could possibly be obtained from the mill engine, and an independent engine has been provided; and in

other instances it has been considered advisable to have the power for the electric light quite independent. In these circumstances, again, an economy in the use of the electric light has been proved, and in a succeeding number we propose to give some details of the cost of working, with the additional charge of independent engines.

### RESEARCHES ON THE ACTION OF ELECTRICITY UPON CERTAIN GASES.

THE researches of Berthelot into the action of electric discharges upon gaseous bodies have come to be regarded as classical by physicists. His results have been accumulated by a patient investigation which it would well become our younger scientists to emulate. Unfortunately, for the cause of true science, the tendency of the times is, in many matters of great importance, becoming characterised by a certain degree of hurry which, if persisted in, will be fatal to many a career, and, what is worse, to many a question of scientific interest and practical usefulness.

Long ago Berthelot began the systematic study of the action of electricity upon gases and vapours. One of these was carbonic oxide [ $\text{CO}$ ]. This gas has been known for more than a hundred years, having first been obtained by Lavoisier in 1776. Priestly was familiar with it but, by some strange delusion he supposed that it was the gas which we now know as hydrogen. Carbonic oxide can be made in many ways, most of which are strictly chemical in character. Amongst other methods that of Buff and Hofmann (vide *Liebig's Annalen der Chemie*, vol. 113, p. 140) is of interest to electricians. They produced it by passing a series of electric sparks through carbonic acid gas,  $\text{CO}_2$ .

Carbonic oxide when pure is a slightly odorous gas without taste or colour, it will burn and it is extremely poisonous.

There are few compound gases but are influenced by the decomposing action of the electric spark. Carbonic oxide is a typical instance of this; electric sparks, according to Berthelot, cause a partial decomposition to carbonic anhydride ( $\text{CO}_2$ ), and if the  $\text{CO}_2$  be removed by absorption the change proceeds (vide *Annales de Chimie et de Physique*, Series 5, Vol. XXX, p. 547).

Dixon, writing in the *Journal of the Chemical Society*, Vol. XLIX., p. 103, states that sparks from a Leyden jar will decompose carbonic oxide, but that only about half per cent. of the total gas is decomposed by this form of electricity. This scientist has also investigated the action of electricity upon a mixture of carbonic oxide and oxygen. He finds that such a mixture is burnt to carbonic anhydride by the application of an electric spark, just as it is by the application of flame. If, however, both gases are perfectly dry, no chemical change occurs when the spark is passed. A mere trace of steam present is sufficient to render the mixture explosive. If only a very small quantity of steam is present, the change takes place very slowly under the action of electricity; but when the amount of steam is increased, the rapidity of the explosion is increased proportionately. It appears that the steam acts as a carrier of oxygen to the carbonic oxide: it is probably reduced to hydrogen, and this is then oxidised again. Dixon's work may be read in the *Transactions of the Royal Society* for 1884, p. 617. Buff and Hofmann thought that a dry mixture of carbonic oxide and oxygen would not explode, but L. Meyer's experiments seem to prove that such a mixture can be exploded if the operator will use a sufficiently strong spark; the temperature is thus made very high. Other conditions, however, appear to be necessary. The gases must be under considerable pressure: the more dilute the gaseous mixture is, the more difficult it is to explode (vide *Berichte der Deutschen Chemischen Gesellschaft*, Vol. XIX., p. 1,099).

When sparks from an induction coil are passed into a mixture of carbonic oxide and steam, the constituents are dissociated and recombined, the result being carbonic anhydride, a little formic acid, and sometimes free carbon. This observation is also due to Dixon.

It has, further, been shown that if hydrogen and oxygen, the constituents of steam, be added to carbonic oxide, the mixture will explode on the application of an electric spark, and carbonic anhydride and water will be formed. The ratio of these products to each other depends, curiously enough, upon the shape of the vessel, and on the pressure up to a certain limit, which may be called the "critical pressure"; above this limit the ratio is independent of the shape of the vessel. It would be interesting to trace the causes of this very curious result.

Returning now to the researches of Berthelot. In the *Bulletin de la Société Chimique de Paris*, series (2), Vol. XXI., p. 102, is a paper in which he asserts that carbonic oxide is decomposed by the silent electric discharge being converted into carbonic anhydride by a brown substance to which he assigned the formula  $\text{C}_5\text{O}_4$ . Brodie, however, argued at the time that the composition was best expressed by the formula  $\text{C}_4\text{O}_3$ .

Now, according to the more recent researches of P. Schutzenberger, the composition of the dark brown product is variable, and, further, the condensation of the carbonic oxide ceases as soon as the gas contains 10 per cent. of carbonic anhydride.

Schutzenberger's experiments, which have just been described before the French Academy of Science, were made with a simple discharge tube of the Wilde-Berthelot form, the open end dipping under mercury, whilst the armatures were acidified water.

Under these conditions the rate of condensation varied considerably, but was practically constant for the same tube used in the same way. The solid product had the composition:—

Carbon ...	...	...	...	45.6
Hydrogen ...	...	...	...	0.6
Oxygen ...	...	...	...	53.8
				100.0

When the armatures of acidified water were replaced by mercury condensation was much slower, and the black product had the composition:—

Carbon ...	...	...	...	46.4
Hydrogen ...	...	...	...	0.9
Oxygen ...	...	...	...	52.7
				100.0

If the armatures were surrounded by jackets containing dry air, and every precaution taken to exclude moisture, very little condensation took place, even when the discharge was continued for 48 hours. It follows that the presence of small quantities of water is essential to the formation of the black product, and Schutzenberger considers that the electric discharge carries oxygen and water through the glass, and that there is also some evidence of a transport of matter in the opposite direction, since the total quantity of carbon in the condensed product and the carbonic anhydride was less than that in the carbonic oxide which disappeared.

Berthelot, in a still more recent contribution to the proceedings of the same learned body, states that condensation of carbonic oxide under the influence of the silent electric discharge takes place even when the gas is separated from water by the walls of two tubes, and by an intervening air space, the gas and the apparatus having been very carefully dried.

The condensation and the composition of the residual gas show that the solid matter has the composition  $\text{C}_4\text{O}_3$ , which confirms his earlier experiments described in the *Bulletin de la Société Chimique de Paris*, Series 2, Vol. XXI., p. 102, and in the *Annales de Chimie et de Physique*, Series 5, Vol. XVII., p. 142.

Berthelot is also at variance with Schutzenberger with regard to the question of the electric discharge causing the passage of water through the glass. He

considers that there is no scientific evidence of it, and that Schutzenburger is only hazarding an opinion.

Schutzenburger, however, has rejoined that in some experiments described in the *Comptes Rendus*, Vol. CX., p. 681, evidence is there given which fully bears out his views. There is, however, reason to believe that the presence of the moisture is to be accounted for by the extreme difficulty of perfectly drying either glass or mercury.

But there is room for independent effort on other lines of research, for evidently the whole truth concerning the action of the silent electric discharge upon carbonic oxide has not yet been revealed.

Quite recently the condensation of benzene and acetylene, under the influence of the silent discharge, has been placed under investigation by Schutzenburger.

Benzene,  $C_6H_6$ , is a hydrocarbon which has not yet been prepared by electrical methods. In its normal state, at ordinary temperature and pressure, it is a colourless, mobile, strongly refracting liquid, which will burn with a luminous flame. It is usually prepared from coal tar by distillation, fractionation and rectification, according to methods which have been developed by Faraday, Hofmann and Mansfield.

Although it has hitherto been found impossible to prepare benzene by the action of electricity, it is susceptible to change under its influence. If induction sparks be passed through liquid benzene, a gaseous mixture is formed which contains 42 per cent. of acetylene and 57 per cent. of hydrogen. This fact was observed by Destrem (vide *Bulletin de la Société Chimique de Paris*, Series 2, Vol. XLII., p. 267).

Acetylene, on the other hand, can be produced by electricity acting upon the elements carbon and hydrogen, of which it is constituted. Acetylene, called, also, ethine and ethylene, is an ill-smelling gas which occurs normally in coal gas. It is generated by the incomplete combustion of hydrocarbons. Its characteristic odour may be observed when a Bunsen-lamp flame "strikes down" and burns within the chimney.

Berthelot prepared acetylene synthetically by passing hydrogen over charcoal, heated to whiteness, in the electric arc (vide *Comptes Rendus*, Vol. LIV., p. 640).

Dewar obtained the same gas when hydrogen was passed through holes drilled through the centre of carbon points at the same time as these points were discharging powerful sparks (vide *Proceedings of the Royal Society*, Vol. XXIX., 1880).

Acetylene can also be made by another method, devised by Berthelot, which consists in exposing marsh, or coal gas, to the sparks of a powerful induction coil (vide *Comptes Rendus*, LIV., p. 515). The vapours of many organic compounds, e.g., alcohol, ether, acetene, ethylene, benzene, &c., likewise yield acetylene, when induction sparks are passed through them. This was discovered by De Wilde. Berthelot has also obtained it by the electrolysis of a solution of potassium aconitate or succinate. To prepare acetylene in large quantity, however, it would be best to resort to purely chemical methods.

The study of the action of the silent discharge upon acetylene and benzene was conducted by Schutzenberger as follows:

The tubes containing the substances to be experimented upon were hermetically sealed, and thus the contents were cut off from any possible absorption of moisture from the air. It was found that after the discharge had been continued for five or six hours, the inner tube was very liable to break, a result due to the fact that the prolonged action of the discharge makes the glass brittle. If the tubes are quite vacuous fracture takes place after a very few minutes.

Under the influence of the silent discharge, benzene vapour gradually condenses to a pale yellow, resinous, transparent solid, the liquid benzene gradually disappearing. The product contains

Carbon	...	...	85.9 to 91.63	per cent.
Hydrogen	...	...	7.1 "	7.81 " "
Oxygen	...	...	0.7 "	7.0 " "

The composition of the product depends upon whether it is formed on the inner tube or the outer tube.

		C.		H.		O.
Inner tube	...	90.54	...	7.30	...	2.10
Outer "	...	87.14	...	7.48	...	5.38

The results agree with those obtained with acetylene, which gives a product containing 2 to 5 per cent. of oxygen.

Schutzenberger also adduces what he considers further evidences of his theory, that the action of the silent electric discharge affects the glass so that it becomes permeable to water.

It is only by carefully studying the chemical and physical properties of substances that we can form any true conception of the nature of these bodies; possibly the same principle may hold with regard to the various phases of electricity, and hence by studying closely their chemical effects upon well-known bodies as well as their own purely physical characteristics, we may in time arrive at a more lucid conception of these also.

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

### LECTURE I.

Historical Introduction—Generalities about Forms and Uses of Electro-magnets—The Magnetic Properties of Iron.

### INTRODUCTORY.

AMONGST the great inventions which have originated in the lecture room in which we are met are two of special interest to electricians—the application of gutta-percha to the purpose of submarine telegraph cables, and the electro-magnet. This latter invention was first publicly described, from the very platform on which I stand, on May 23rd, 1825, by William Sturgeon, whose paper is to be found in the forty-third volume of the "Transactions of the Society of Arts." For this invention we may rightfully claim the very highest place. Electrical engineering, the latest and most vigorous offshoot of applied science, embraces many branches. The dynamo for generating electric currents, the motor for transforming their energy back into work, the arc lamp, the electric bell, the telephone, the recent electro-magnetic machinery for coal mining, for the separation of ore, and many other electro-mechanical contrivances, come within the purview of the electrical engineer. In every one of these, and in many more of the useful applications of electricity, the central organ is an electro-magnet. By means of this simple and familiar contrivance—an iron core surrounded by a copper wire coil—mechanical actions are produced at will, at a distance, under control, by the agency of electric currents. These mechanical actions are known to vary with the mass, form, and quality of the iron core, the quantity and disposition of the copper wire wound upon it, the quantity of the electric current circulating around it, the form, quality, and distance of the iron armature upon which it acts. But the laws which govern the mechanical action in relation to these various matters are by no means well known, and, indeed, several of them have long been a matter of dispute. Gradually, however, that which has been vague and indeterminate becomes clear and precise. The laws of the steady circulation of electric currents, at one time altogether obscure, were cleared up by the discovery of the famous law of Ohm. Their extension to the case of rapidly interrupted currents, such as are used in telegraphic working, was discovered by Helmholtz; whilst to Maxwell is due their further extension to alternating, or, as they are sometimes called, undulatory currents. All this was purely electric work. But the law of the electro-magnet was still undiscovered; the magnetic part of the problem was still buried in obscurity. The only exact reasoning about magnetism dealt with problems of another kind; it was couched in language of a misleading character; for the practical problems connected with the electro-magnet it was worse than useless. The doctrine of two magnetic fluids distributed over the end surfaces of magnets, which under the sanction of the great names of Coulomb, of Poisson, and of Laplace, had unfortunately become recognised as an accepted part of science, along with the law of inverse squares. How greatly the progress of electro-magnetic science has been impeded and retarded by the weight of these great names it is impossible now to gauge. We now know that for all purposes, save only those whose value lies in the domain of abstract mathematics, the doctrine of the two magnetic fluids is false and misleading. We know that magnetism, so far from residing on the end or surface of the magnet, is a pro-

\* Cantor Lecture. Delivered before the Society of Art January 20th, 1890.

perty resident throughout the mass; that the internal not the external magnetisation is the important fact to be considered; that the so-called free magnetism on the surface is, as it were, an accidental phenomenon; that the magnet is really most highly magnetised at those parts where there is least surface magnetisation; finally, that the doctrine of surface distribution of fluids is absolutely incompetent to afford a basis of calculation such as is required by the electrical engineer. He requires rules to enable him not only to predict the lifting power of a given electro-magnet, but also to guide him in designing and constructing electro-magnets of special forms suitable for the various cases that arise in his practice. He wants in one place a strong electro-magnet to hold on to its armature like a limpet to its native rock; in another case he desires a magnet having a very long range of attraction, and wants a rule to guide him to the best design; in another he wants a special form having the most rapid action attainable; in yet another he must sacrifice everything else to attain maximum action with minimum weight. Toward the solution of such practical problems as these the old theory of magnetism offered not the slightest aid. Its array of mathematical symbols was a mockery. It was as though an engineer asking for rules to enable him to design the cylinder and piston of an engine were confronted with receipts how to estimate the cost of painting it.

Gradually, however, new light dawned. It became customary, in spite of the mathematicians, to regard the magnetism of a magnet as something that traverses or circulates round a definite path, flowing more freely through such substances as iron, than through other relatively non-magnetic materials. Analogies between the flow of electricity in an electrically-conducting circuit, and the passage of magnetic lines of force through circuits possessing magnetic conductivity, forced themselves upon the minds of experimenters, and compelled a mode of thought quite other than the previously accepted. So far back as 1821, Cumming\* experimented on magnetic conductivity. The idea of a magnetic circuit was more or less familiar to Ritchie,† Sturgeon,‡ Dove,§ Dub,|| and De La Rive,¶ the last-named of whom explicitly uses the phrase, "a closed magnetic circuit." Joule\*\* found the maximum power of an electro-magnet to be proportional to "the least sectional area of the entire magnetic circuit," and he considered the resistance to induction as proportional to the length of the magnetic circuit. Indeed, there are to be found scattered in Joule's writings on the subject of magnetism, some five or six sentences, which, if collected together, constitute a full statement of the whole matter. Faraday,†† considered that he had proved that each demagnetic line of force constitutes a closed curve; that the path of these closed curves depended on the magnetic conductivity of the masses disposed in proximity; that the lines of magnetic force were strictly analogous to the lines of electric flow in an electric circuit. He spoke of a magnet surrounded by air being like unto a voltaic battery immersed in water or other electrolyte. He even saw the existence of a power, analogous to that of electromotive force in electric circuits, though the name, "magnetomotive force," is of more recent origin. The notion of magnetic conductivity is to be found in Maxwell's great treatise (vol. ii., p. 51), but is only briefly mentioned. Rowland,‡‡ in 1873, expressly adopted the reasoning and language of Faraday's method in the working out of some new results on magnetic permeability, and pointed out that the flow of magnetic lines of force through a bar could be subjected to exact calculation; the elementary law, he says, "is similar to the law of Ohm." According to Rowland, the "magnetising force of helix" was to be divided by the "resistance to the lines of force," a calculation for magnetic circuits which every electrician will recognise as precisely as Ohm's law for electric circuits. He applied the calculations to determine the permeability of certain specimens of iron, steel, and nickel. In 1882,§§ and again in 1883, Mr. R. H. M. Bosanquet||| brought out at greater length a similar argument, employing the extremely apt term, "Magnetomotive Force," to connote the force tending to drive the magnetic lines of induction through the "magnetic resistance," or, as it will be frequently called in these lectures, the magnetic "reluctance" of the circuit. In these papers the calculations are reduced to a system, and deal not only with the specific properties of iron, but with problems arising out of the shape of

the iron. Bosanquet shows how to calculate the several resistances (or reluctances) of the separate parts of the circuit, and then add them together to obtain the total resistance (or reluctance) of the magnetic circuit.

Prior to this, however, the principle of the magnetic circuit had been seized upon by Lord Elphinstone and Mr. Vincent, who proposed to apply it in the construction of the dynamo-electric machines. On two occasions\* they communicated to the Royal Society the results of experiments to show that the same exciting current would evoke a larger amount of magnetism in a given iron structure, if that iron structure formed a closed magnetic circuit, than if it were otherwise disposed.

In recent years the notion of the magnetic circuit has been vigorously taken up by the designers of dynamo machines, who, indeed, base the calculation of their designs upon this all-important principle. Having this, they need no laws of inverse squares of distances, no magnetic moments, none of the elaborate expressions for surface distribution of magnetism, none of the ancient paraphernalia of the last century. The simple law of the magnetic circuit, and a knowledge of the properties of iron, are practically all they need. About four years ago, much was done by Mr. Gisbert Kapp† and by Drs. J. and E. Hopkinson‡ in the application of these considerations to the design of dynamo machines, which previously had been a matter of empirical practice. To this end the formulæ of Prof. Forbes§ for calculating magnetic leakage, and the researches of Profs. Ayrton and Perry|| on magnetic shunts, contributed a not unimportant share. As the result of the advances made at that time, the subject of dynamo design was reduced to an exact science.

It is the aim and object of the present course or lectures to show how the same considerations which have been applied with such great success to the subject of the design of dynamo electric machines may be applied to the study of the electro-magnet. The theory and practice of the design and construction of electro-magnets will thus be placed, once for all, upon a rational basis. Definite rules will be laid down for the guidance of the constructor, directing him as to the proper dimensions and form of iron to be chosen, and as to the proper size and amount of copper wire to be wound upon it in order to produce any desired result.

First, however, a historical account of the invention will be given, followed by a number of general considerations respecting the uses and forms of electro-magnets. These will be followed by a discussion of the magnetic properties of iron and steel and other materials; some account being added of the methods used for determining the magnetic permeability of various brands of iron at different degrees of saturation. Tabular information is given as to the results found by different observers. In connection with the magnetic properties of iron the phenomenon of magnetic hysteresis is also described and discussed. The principle of the magnetic circuit is then discussed with numerical examples, and a number of experimental data respecting the performance of electro-magnets are adduced, in particular those bearing upon the tractive power of electro-magnets. The law of traction between an electro-magnet and its armature is then laid down, followed by the rules for pre-determining the iron cores and copper coils required to give any prescribed tractive force.

Then comes the extension of the calculation of the magnetic circuit to those cases where there is an air gap between the poles of the magnet and the armature; and where, in consequence, there is leakage of the magnetic lines from pole to pole. The rules for calculating the winding of the copper coils are stated, and the limiting relation between the magnetising power of the coil and the heating effect of the current in it is explained. After this comes a detailed discussion of the special varieties of form that must be given to electro-magnets in order to adapt them to special services. Those which are designed for maximum traction, for quickest action, for longest range, for greatest economy when used in continuous daily service, for working in series with constant current, for use in parallel at constant pressure, and those for use with alternate currents, are separately considered.

Lastly, some account is given of the various forms of electro-magnet mechanism which have arisen in connection with the invention of the electro-magnet. The plunger and coil is specially considered as constituting a species of electro-magnet adapted for a long range of motion. Modes of mechanically securing long range for electro-magnets, and of equalising their pull over the range of motion of the armature, are also described. The analogies between sundry electro-mechanical movements, and the corresponding pieces of ordinary mechanism are traced out. The course is concluded by a consideration of the various modes of preventing or minimising the sparks which occur in the circuits in which electro-magnets are used.

#### HISTORICAL SKETCH.

The effect which an electric current, flowing in a wire, can exercise upon a neighbouring compass needle was discovered by

\* "Proc. Roy. Soc.," xxix., p. 292, 1879, and xxx., p. 287, 1880. See ELECTRICAL REVIEW, viii., p. 134, 1880.

† The *Electrician*, vols. xiv., xv., and xvi., 1885-6; also "Proc. Inst. Civil Engineers," lxxxiii., 1885-6; and "Journ. Soc. Electr. Engineers," xv., 524, 1886.

‡ "Phil. Trans.," 1886, pt. i., p. 331; and *The Electrician* xviii., pp. 39, 63, 86, 1886.

§ "Journ. Soc. Electr. Engineers," xv., 555, 1886.

|| "Journ. Soc. Electr. Engineers," xv., 530, 1886.

\* "Camb. Phil. Trans.," April 2nd, 1821.

† "Phil. Mag.," series iii., vol. iii., p. 122.

‡ "Ann. of Electr.," xii., p. 217.

§ "Pogg. Ann.," xxix., p. 462, 1833. See also "Pogg. Ann.," xliii., p. 517, 1838.

|| "Dub. Elektromagnetismus" (ed. 1861), p. 401; and "Pogg. Ann.," xc., p. 440, 1853.

¶ De La Rive. "Treatise on Electricity" (Walker's translation), vol. i., p. 292.

\*\* "Ann. of Electr.," iv., 59, 1839; v., 195, 1841; and "Scientific Papers," pp. 8, 34, 35, 36.

†† "Experimental Researches," vol. iii., art. 3117, 3228, 3230, 3260, 3271, 3276, 3294, and 3361.

‡‡ "Phil. Mag.," series iv., vol. xvi., August, 1873, "On Magnetic Permeability and the Maximum of Magnetism of Iron, Steel, and Nickel."

§§ "Proc. Royal Soc.," xxxiv., p. 445, December, 1882.

||| "Phil. Mag.," series v., vol. xv., p. 205, March, 1883. "On Magneto-Motive Force." Also *ib.*, vol. xix., February, 1885, and "Proc. Roy. Soc." No. 223, 1883. See also *Electrician*, xiv., p. 291, February 14th, 1885.

Oersted in 1820.\* This first announcement of the possession of magnetic properties by an electric current was followed speedily by the researches of Ampère,† Arago,‡ Davy,§ and by the devices of several other experimenters, including De la Rives|| floating battery and coil, Schweigger's¶ multiplier, Cumming's\*\* galvanometer, Faraday's†† apparatus for rotation of a permanent magnet, Marsh's‡‡ vibrating pendulum, and Barlow's§§ rotating star-wheel. But it was not until 1825 that the electro-magnet was invented. Davy had, indeed, in 1821, surrounded with temporary coils of wire the steel needles upon which he was experimenting, and had shown that the flow of electricity around the coil could confer magnetic power upon the steel needles. But from this experiment it was a grand step forward to the discovery that a core of soft iron, surrounded by its own appropriate coil of copper, could be made to act not only as a powerful magnet, but as a magnet whose power could be turned on or off at will, could be augmented to any desired degree, and could be set into action and controlled from a practically unlimited distance.

The electro-magnet, in the form which can first claim recognition for these qualities, was devised by William Sturgeon,||| and is described by him in the paper which he contributed to the proceedings of the Society of Arts in 1825, accompanying a set of improved apparatus for electro-magnetic experiments.¶¶ The

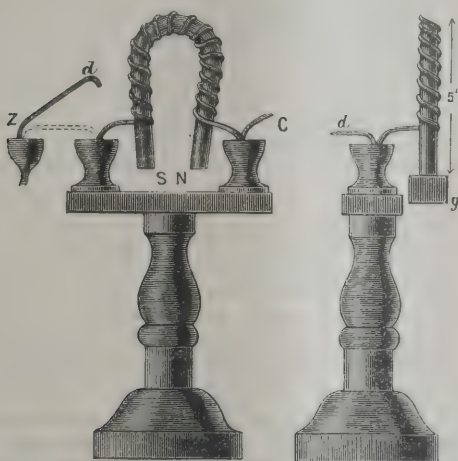


FIG. 1.

FIG. 2.

STURGEON'S FIRST ELECTRO-MAGNET.

Society of Arts rewarded Sturgeon's labours by awarding him the silver medal of the Society and a premium of thirty guineas. Amongst this set of apparatus are two electro-magnets, one of

horseshoe shape (figs. 1 and 2) and one a straight bar (fig. 3). It will be seen that the former figures represent an electro-magnet consisting of a bent iron rod about one foot long and half inch in diameter, varnished over and then coiled with a single left-handed spiral of stout uncovered copper wire of 18 turns. This coil was found appropriate to the particular battery which Sturgeon preferred, namely, a single cell containing a spirally enrolled pair of zinc and copper plates of large area (about 130 square inches) immersed in acid; which cell, having small internal resistance would yield a large quantity of current when connected to a circuit of small resistance. The ends of the copper wire were brought out sideways and bent down so as to dip into two deep connecting cups, marked z and c, fixed upon a wooden stand. These cups, which were of wood, served as supports to hold up the electro-magnet, and, having mercury in them, served also to make good electrical connection. In fig. 2 the magnet is seen sideways, supporting a bar of iron, y. The circuit was completed to the battery through a connecting wire, d, which could be lifted out of the cup, z, so breaking circuit when desired, and allowing the weight to drop. Sturgeon added in his explanatory remarks that the poles, N and S, of the magnet will be reversed if you wrap the copper wire about the rod as a right-handed screw, instead of a left-handed one, or, more simply, by reversing the connections with the battery, by causing the wire that dips into the z cup to dip into the c cup, and vice versa. This electro-magnet was capable of supporting 9 lbs. when thus excited.

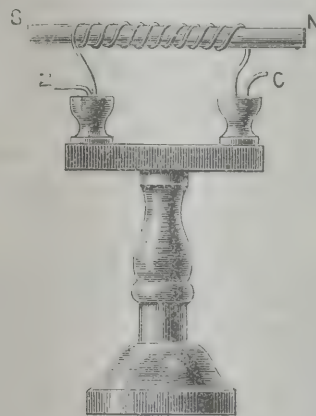


FIG. 3.—STURGEON'S STRAIGHT BAR ELECTRO-MAGNET.

Fig. 3 shows another arrangement to fit on the same stand. This arrangement communicates magnetism to hardened steel bars, as soon as they are put in, and renders soft iron within it magnetic during the time of action; it only differs from figs. 1 and 2 in being straight, and thereby allows the steel or iron bar to slide in and out.

For this piece of apparatus and other adjuncts accompanying it, all of which are described in the Society's "Transactions" for 1825, Sturgeon, as already stated, was awarded the Society's silver medal and a premium of 30 guineas. The apparatus was deposited in the museum of the Society, which therefore might be supposed to be the proud possessor of the first electro-magnet ever constructed. Alas for the vanity of human affairs, the Society's museum of apparatus has long been dispersed, this priceless relic having been either made over to the now defunct Patent Office Museum, or otherwise lost sight of.

Sturgeon's first electro-magnet, the core of which, weighing about 7 oz., was able to sustain a load of 9 lbs., or about 20 times its own weight. At the time it was considered a truly remarkable performance. Its single layer of stout copper wire was well adapted to the battery employed, a single cell of Sturgeon's own particular construction, having a surface of 130 square inches, and therefore of small internal resistance. Subsequently, in the hands of Joule, the same electro-magnet sustained a load of 50 lbs., or about 114 times its own weight. Writing in 1832 about his apparatus of 1825, Sturgeon used the following magniloquent language:—

"When first I showed that the magnetic energies of a galvanic conducting wire are more conspicuously exhibited by exercising them on soft iron than on hard steel, my experiments were limited to small masses—generally to a few inches of rod iron of about half an inch in diameter. Some of those pieces were employed while straight, and others were bent into the form of a horse-shoe magnet, each piece being encompassed by a spiral conductor of copper wire. The magnetic energies developed by those simple arrangements are of a very distinguished and exalted character, as is conspicuously manifested by the suspension of a considerable weight at the poles during the period of excitation by the electric influence.

"An unparalleled transiency of magnetic action is also displayed in soft iron, by an instantaneous transition from a state of total inactivity to that of vigorous polarity, and also by a simultaneous reciprocity of polarity in the extremities of the bar—versatilities in this branch of physics for the display of which soft iron is pre-eminently qualified, and which, by the agency of electricity, become demonstrable with the celerity of thought, and

\* See Thomson's "Annals of Philosophy," Oct., 1820.

† "Ann. de Chim. et de Physique," xv., 59 and 170, 1820.

‡ *Ib.*, xv., 93, 1820.

§ "Phil. Trans.," 1821.

|| "Bibliothèque Universelle," March, 1821.

¶ *Ib.*

\*\* "Camb. Phil. Trans.," 1821.

†† "Quarterly Journal of Science," Sept., 1821.

‡‡ Barlow's "Magnetic Attractions," second edition, 1823.

§§ *Ib.*

||| William Sturgeon, the inventor of the electro-magnet, was born at Whittington, in Lancashire, in 1783. Apprenticed as a boy to the trade of a shoemaker, at the age of nineteen he joined the Westmoreland Militia, and two years later enlisted into the Royal Artillery, thus gaining the chance of learning something of science, and having leisure in which to pursue his absorbing passion for chemical and physical experiments. He was forty-two years of age when he made his great, though at the time unrecognised, invention. At the date of his researches in electro-magnetism, he was resident at 8, Artillery Place, Woolwich, at which place he was the associate of Marsh, and was intimate with Barlow, Christie, and Gregory, who interested themselves in his work. In 1835 he presented a paper to the Royal Society, containing descriptions, *inter alia*, of a magneto-electric machine with longitudinally-wound armature, and with a commutator consisting of half-disks of metal. For some reason this paper was not admitted to the "Philosophical Transactions;" he afterwards printed it in full, without alteration, in his volume of Scientific Researches, published by subscription in 1850. From 1836 to 1843 he conducted the "Annals of Electricity." He had now removed to Manchester, where he lectured on electricity at the Royal Victoria Gallery. He died at Prestwich, near Manchester, in 1850. There is a tablet to his memory in the church at Kirkby Lonsdale, from which town the village of Whittington is distant about two miles. A portrait of Sturgeon in oils, and said to be an excellent likeness, is believed still to be in existence; but all inquiries as to its whereabouts have proved unavailing. At the present moment, so far as I am aware, the scientific world is absolutely without a portrait of the inventor of the electro-magnet.

¶¶ "Trans. Society of Arts," 1825, xliii., p. 38.

illustrated by experiments the most splendid in magnetism. It is, moreover, abundantly manifested by ample experiments that galvanic electricity exercises a superlative degree of excitation on the latent magnetism of soft iron, and calls for its recondite powers with astonishing promptitude, to an intensity of action far surpassing anything which can be accomplished by any known application of the most vigorous permanent magnet, or by any other mode of experimenting hitherto discovered. It has been observed, however, by experimenting on different pieces selected from various sources, that, notwithstanding the greatest care be observed in preparing them of a uniform figure and dimensions, there appears a considerable difference in the susceptibility which they individually possess of developing the magnet powers, much of which depends upon the manner of treatment at the forge, as well as upon the natural character of the iron itself.\*

"The superlative intensity of electro-magnets, and the facility and promptitude with which their energies can be brought into play, are qualifications admirably adapted for their introduction into a variety of arrangements in which powerful magnets so essentially operate, and perform a distinguished part in the production of electro-magnet rotations; whilst the versatilities of polarity of which they are susceptible are eminently calculated to give a pleasing diversity in the exhibition of that highly interesting class of phenomena, and lead to the production of others inimitable by any other means."†

Sturgeon's further work during the next three years is best described in his own words:—

"It does not appear that any very extensive experiments were attempted to improve the lifting power of electro-magnets, from the time that my experiments were published in the 'Transactions of the Society of Arts, &c.,' for 1825, till the latter part of 1828. Mr. Watkins, philosophical instrument maker, Charing Cross, had, however, made them of much larger size than any which I had employed, but I am not aware to what extent he pursued the experiment.

"In the year 1828, Prof. Moll, of Utrecht, being on a visit to London, purchased of Mr. Watkins an electro-magnet weighing about 5 lbs.—at that time I believe the largest which had been made. It was of round iron, about one inch in diameter, and furnished with a single copper wire twisted round it eighty-three times. When this magnet was excited by a large galvanic surface, it supported about 75 lbs. Prof. Moll afterwards prepared another electro-magnet, which, when bent, was 12½ inches high, 2½ inches in diameter, and weighed about 26 lbs.; prepared like the former with a single spiral conducting wire. With an acting galvanic surface of 11 square feet, this magnet would support 154 lbs., but would not lift an anvil which weighed 200 lbs.

"The largest electro-magnet which I have yet (1832) exhibited in my lectures weighs about 16 lbs. It is formed of a small bar of soft iron, 1½ inch across each side; the cross piece, which joins the poles, is from the same rod of iron, and about 3½ inches long. Twenty separate strands of copper wire, each strand about 50 feet in length, are coiled round the iron, one above another, from pole to pole, and separated from each other by intervening cases of silk. The first coil is only the thickness of one ply of silk from the iron; the twentieth, or outermost, about half-an-inch from it. By this means the wires are completely insulated from each other without the trouble of covering them with thread or varnish. The ends of wire project about two feet, for the convenience of connection. With one of my small cylindrical batteries, exposing about 150 square inches of total surface, this electro-magnet supports 400 lbs. I have tried it with a larger battery, but its energies do not seem to be so materially exalted as might have been expected by increasing the extent of galvanic surface. Much depends upon a proper acid solution; good nitric or nitrous acid, with about six or eight times its quantity of water, answers very well. With a new battery of the above dimensions and a strong solution of salt and water, at a temperature of 190° Fahr., the electro-magnet supported between 70 and 80 lbs., when the first seventeen coils only were in the circuit. With the three exterior coils alone in the circuit, it would just support the lifter, or cross piece. When the temperature of the solution was between 40° and 50°, the magnetic force excited was comparatively very feeble. With the innermost coil alone, and a strong acid solution, this electro-magnet supports about 100 lbs.; with the four outermost wires, about 250 lbs. It improves in power with every additional coil until about the twelfth, but not perceptibly any further; therefore the remaining eight coils appear to be useless, although the last three, independently of the innermost seventeen, and at the distance of half-an-inch from the iron, produce in it a lifting power of 75 lbs.

"Mr. Marsh has fitted up a bar of iron much larger than mine, with a similar distribution of the conducting wires to that devised

and so successfully employed by Professor Henry. Mr. Marsh's electro-magnet will support about 560 lbs. when excited by a galvanic battery similar to mine. These two, I believe, are the most powerful electro-magnets yet produced in this country.

"A small electro-magnet, which I also employ on the lecture table, and the manner of its suspension is represented by fig. 4. The magnet is of cylindric rod iron, and weighs four ounces; its poles are about a quarter of an inch asunder. It is furnished with six coils of wire in the same manner as the large electro-magnet before described, and will support upwards of 50 lbs.

"I find a triangular gin very convenient for the suspension of the magnet in these experiments. A stage of thin board, supporting two wooden dishes, fastened, at a proper height, to two of the legs of the gin. Mercury is placed in these vessels, and the dependent amalgamated extremities of the conducting wires dip into it—one into each portion.

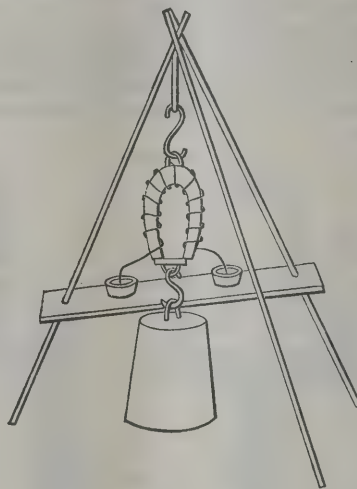


FIG. 4.—STURGEON'S LECTURE-TABLE ELECTRO-MAGNET.

"The vessels are sufficiently wide to admit of considerable motion of the wires in the mercury without interrupting the contact, which is sometimes occasioned by the swinging of the magnet and attached weight. The circuit is completed by other wires, which connect the battery with these two portions of mercury. When the weight is supported as in the figure, if an interruption be made by removing either of the connecting wires, the weight instantaneously drops on the table. The large magnet I suspend in the same way on a larger gin; the weights which it supports are placed one after another on a square board, suspended by means of a cord at each corner from a hook in the cross-piece, which joins the poles of the magnet.

"With a new battery, and a solution of salt and water, at a temperature of 190° Fahr., the small electro-magnet, fig. 3, supports 16 lbs."

In 1840, after Sturgeon had removed to Manchester, where he assumed the management of the "Victoria Gallery of Practical Science," he continued his work, and in the seventh memoir in his series of researches he wrote as follows:—

"The electro-magnet belonging to this Institution is made of a cylindrical bar of soft iron, bent into the form of a horse-shoe magnet, having the two branches parallel to each other, and at the distance of 4½ inches. The diameter of the iron is 2.75 inches, it is 18 inches long when bent. It is surrounded by 14 coils of copper wire, seven on each branch. The wire which constitutes the coils is ⅛th of an inch diameter, and in each coil there are about 70 feet of wire. They are united in the usual way with branch wires, for the purpose of conducting the currents from the battery. The magnet was made by Mr. Nesbit. . . . The greatest weight sustained by the magnet in these experiments is 12½ cwt., or 1,386 lbs., which was accomplished by 16 pairs of plates, in four groups of four pairs in series each. The lifting power by 19 pairs in series was considerably less than by ten pairs in series; and but very little greater than that given by one cell or one pair only. This is somewhat remarkable, and shows how easily we may be led to waste the magnetic powers of batteries by an injudicious arrangement of its elements."\*

At the date of Sturgeon's work the laws governing the flow of electric currents in wires were still obscure. Ohm's epoch-making enunciation of the law of the electric circuit appeared in "Poggendorff's Annalen" in the very year of Sturgeon's discovery, 1825, though his complete book appeared only in 1827, and his work, translated by Dr. Francis into English, only appeared (in Taylor's "Scientific Memoirs," vol. ii.) in 1841. Without the guidance of Ohm's law it was not strange that even the most able experimenters should not understand the relations between battery and circuit which would give them the best effects. These had to be found by the painful method of trial and failure. Pre-eminent amongst those who tried was Prof. Joseph Henry, then of the Albany Institute, in New York, later of Princeton, New Jersey, who succeeded in effecting an important improvement. In 1828,

\* "I have made a number of experiments on small pieces, from the results of which it appears that much hammering is highly detrimental to the development of magnetism in soft iron, whether the exciting cause be galvanic or any other. And although good annealing is always essential, and facilitates to a considerable extent the display of polarity, that process is very far from restoring to the iron that degree of susceptibility which it frequently loses by the operation of the hammer. Cylindric rod iron of small dimensions may very easily be bent into the required form, without any hammering whatever; and I have found that small electro-magnets made in this way display the magnetic powers in a very exalted degree."

† Sturgeon's "Scientific Researches," p. 113.

\* Sturgeon's "Scientific Researches," p. 188.

led on by a study of the "multiplier" (or galvanometer), he proposed to apply to electro-magnetic apparatus the device of winding them with a spiral coil of wire "closely turned on itself," the wire being of copper from  $\frac{1}{16}$ th to  $\frac{1}{8}$ th of an inch in diameter, covered with silk. In 1831 he thus describes\* the results of his experiments:—

"A round piece of iron, about  $\frac{1}{4}$  of an inch in diameter, was bent into the usual form of a horse-shoe, and instead of loosely coiling around it a few feet of wire, as is usually described, it was tightly wound with 35 feet of wire, covered with silk, so as to form about 400 turns; a pair of small galvanic plates, which could be dipped into a tumbler of diluted acid, was soldered to the ends of the wire, and the whole mounted on a stand. With these small plates the horse-shoe became much more powerfully magnetic than another of the same size, and wound in the same manner, by the application of a battery composed of 28 plates of copper and zinc, each eight inches square. Another convenient form of this apparatus was contrived by winding a straight bar of iron, 9 inches long, with 35 feet of wire, and supporting it horizontally on a small cup of copper containing a cylinder of zinc—when this cup, which served the double purpose of a stand and the galvanic element, was filled with dilute acid, the bar became a portable electro-magnet. These articles were exhibited to the institute in March, 1829. The idea afterwards occurred to me that a sufficient quantity of galvanism was furnished by the two small plates, to develop, by means of the coil, a much greater magnetic power in a larger piece of iron. To test this, a cylindrical bar of iron half an inch in diameter, and about 10 inches long, was bent into the shape of a horseshoe, and wound with 30 feet of wire; with a pair of plates containing only  $2\frac{1}{2}$  square inches of zinc, it lifted 15 lbs. avoirdupois. At the same time, a very material improvement in the formation of the coil suggested itself to me on reading a more detailed account of Prof. Schweigger's galvanometer, and which was also tested with complete success upon the same horseshoe. It consisted in using several strands of wire, each covered with silk, instead of one. Agreeably to this construction, a second wire, of the same length as the first, was wound over it, and the ends soldered to the zinc and copper in such a manner that the galvanic current might circulate in the same direction in both, or, in other words, that the two wires might act as one. The effect by this addition was doubled, as the horseshoe, with the same plates before used, now supported 28 lbs.

"With a pair of plates four inches by six inches, it lifted 39 lbs., or more than fifty times its own weight.

"These experiments conclusively proved that a great development of magnetism could be effected by a very small galvanic element, and also that the power of the coil was materially increased by multiplying the number of wires without increasing the number of each."†

Not content with these results, Prof. Henry pushed forward on the line that he had thus struck out. He was keenly desirous to ascertain how large a magnetic force he could produce when using only currents of such a degree of smallness as could be transmitted through the comparatively thin copper wires, such as bell-hangers use. During the year 1830 he made great progress in this direction, as the following extracts show:—

"In order to determine to what extent the coil could be applied in developing magnetism in soft iron, and also to ascertain, if possible, the most proper lengths of the wires to be used, a series of experiments was instituted jointly by Dr. Philip Ten Eyck and myself. For this purpose 1,060 feet (a little more than one-fifth of a mile) of copper wire of the kind called bell wire, .045 of an inch in diameter, were stretched several times across the large room of the Academy.

"Experiment 1.—A galvanic current from a single pair of plates of copper and zinc two inches square was passed through the whole length of the wire, and the effect on a galvanometer noted. From the mean of several observations, the deflection of the needle was  $15^{\circ}$ .

"Experiment 2.—A current from the same plates was passed through half the above length, or 530 feet of wire; the deflection in this instance was  $21^{\circ}$ .

By a reference to a trigonometrical table, it will be seen that the natural tangents of  $15^{\circ}$  and  $21^{\circ}$  are very nearly in the ratio of the square roots of 1 and 2, or of the relative lengths of the wires in these two experiments.

"The length of the wire forming the galvanometer may be neglected, as it was only 8 feet long.

"Experiment 3.—The galvanometer was now removed, and the whole length of the wire attached to the ends of the wire of a small soft iron horse-shoe a quarter of an inch in diameter, and wound with about 8 feet of copper wire with a galvanic current from the plates used in Experiments 1 and 2. The magnetism was scarcely observable in the horseshoe.

"Experiment 4.—The small plates were removed, and a battery composed of a piece of zinc plate 4 inches by 7 inches, surrounded with copper, was substituted. When this was attached immediately to the ends of the 8 feet of wire wound round the horseshoe, the weight lifted was  $4\frac{1}{2}$  lbs.: when the current was passed through the whole length of wire (1,060 feet) it lifted about half an ounce.

"Experiment 5.—The current was passed through half the length of wire (530 feet) with the same battery; it then lifted two ounces.

"Experiment 6.—Two wires of the same length as in the last experiment were used, so as to form two strands from the zinc and copper of the battery; in this case the weight lifted was four ounces.

"Experiment 7.—The whole length of the wire was attached to a small trough on Mr. Cruikshank's plan, containing 25 double plates, and presenting exactly the same extent of zinc surface to the action of the acid, as the battery used in the last experiment. The weight lifted in this case was 8 oz.; when the intervening wire was removed, and the trough attached directly to the ends of the wire surrounding the horseshoe, it lifted only seven ounces.

"It is possible that the different states of the trough, with respect to dryness, may have exerted some influence on this remarkable result; but that the effect of a current from a trough, if not increased, is but slightly diminished in passing through a long wire is certain.

"But, be this as it may, the fact that the magnetic action of a current from a trough is, at least, not sensibly diminished by passing through a long wire is directly applicable to Mr. Barlow's project of forming an electro-magnetic telegraph; and it is also of material consequence in the construction of the galvanic coil. From these experiments it is evident that in forming the coil we may either use one very long wire or several shorter ones, as the circumstances may require; in the first case, our galvanic combinations must consist of a number of plates, so as to give 'projectile force;' in the second it must be formed of a single pair.

"In order to test on a large scale the truth of these preliminary results, a bar of soft iron, 2 inches square and 20 inches long, was bent into the form of a horseshoe,  $9\frac{1}{2}$  inches high; the sharp edges of the bar were first a little rounded by the hammer, it weighed 21 lbs.; a piece of iron from the same bar, weighing 7 lbs., was filed perfectly flat on one surface, for an armature or lifter; the extremities of the legs of the horse-shoe were also truly ground to the surface of the armature; around this horseshoe 540 feet of copper bell-wire were wound in 9 coils of 60 feet each: these coils were not continued around the whole length of the bar, but each strand of wire according to the principle before mentioned, occupied about two inches, and was coiled several

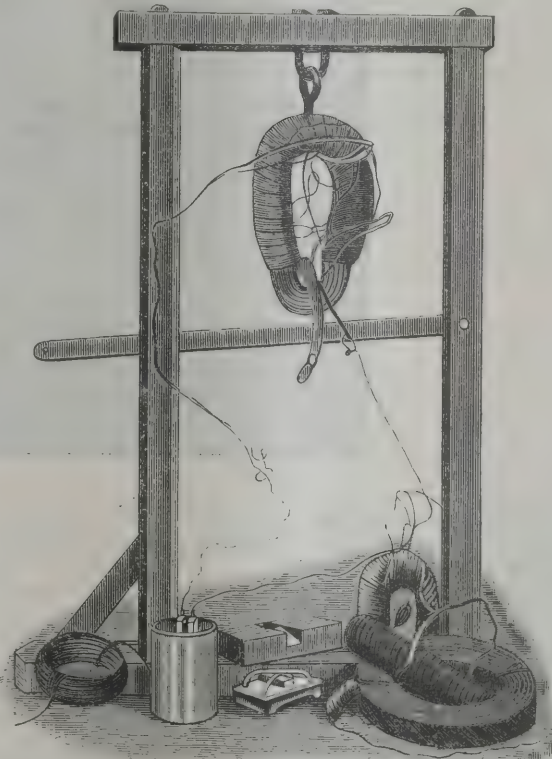


FIG. 5.—HENRY'S ELECTRO-MAGNET.

This figure, copied from the *Scientific American*, December 11th, 1880, represents Henry's electro-magnet, still preserved in Princeton College. The other apparatus at the foot, including a current-reverser, and the ribbon-coil used in the famous experiments on secondary and tertiary currents, were mostly constructed by Henry's own hands.

times backward and forward over itself; the several ends of the wires were left projecting and all numbered, so that the first and last end of each strand might be readily distinguished. In this manner we formed an experimental magnet on a large scale, with which several combinations of wire could be made by merely uniting the different projecting ends. Thus if the second end of the first wire be soldered to the first end of the second wire, and so on through all the series, the whole will form a continued coil of one long wire.

"By soldering different ends the whole may be formed into a double coil of half the length, or into a triple coil of one-third the length, &c. The horseshoe was suspended in a strong

\* Silliman's "American Journal of Science," January, 1831, xix., p. 400.

† "Scientific Writings of Joseph Henry," p. 39.

rectangular wooden frame, three feet nine inches high and twenty inches wide, an iron bar was fixed below the magnet, so as to act as a lever of the second order; the different weights supported were estimated by a sliding weight in the same manner as with a common steel-yard (see sketch). In the experiments immediately following (all weights being avoirdupois) a small single battery was used, consisting of two concentric copper cylinders with zinc between them; the whole amount of zinc surface exposed to the acid from both sides of the zinc was  $\frac{3}{4}$ th of a square foot; the battery required only half a pint of dilute acid for its submersion.

"Experiment 8.—Each wire of the horseshoe was soldered to the battery in succession, one at a time; the magnetism developed by each was just sufficient to support the weight of the armature, weighing 7 lbs.

"Experiment 9.—Two wires, one on each side of the arch of the horseshoe, were attached; the weight lifted was 145 lbs.

"Experiment 10.—With two wires, one from each extremity of the legs, the weight lifted was 200 lbs.

"Experiment 11.—With three wires, one from each extremity of the legs and one from the middle of the arch, the weight supported was 300 lbs.

"Experiment 12.—With four wires, two from each extremity, the weight lifted was 500 lbs. and the armature; when the acid was removed from the zinc, the magnet continued to support for a few minutes 130 lbs.

"Experiment 13.—With six wires the weight supported was 570 lbs.; in all these experiments the wires were soldered to the galvanic element; the convection in no case was formed with mercury.

"Experiment 14.—When all the wires (nine in number) were attached, the maximum weight lifted was 650 lbs., and this astonishing result, it must be remembered, was produced by a battery, containing only  $\frac{3}{4}$ ths of a square foot of zinc surface, and requiring only half a pint of dilute acid for its submersion.

"Experiment 15.—A small battery, formed with a plate of zinc 12 inches long and 6 inches wide, and surrounded by copper, was substituted for the galvanic elements used in the last experiment; the weight lifted in this case was 750 lbs.

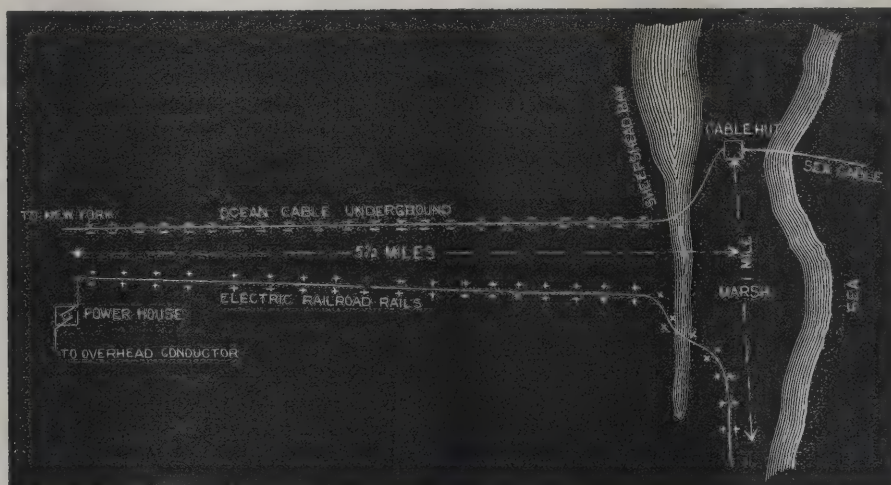
for silk thread, which in these investigations became a very considerable item of expense. He also made a number of experiments with iron bonnet wire, which being found in commerce already wound, might possibly be substituted in place of copper. The result was that with very short wire the effect was nearly the same as with copper, but in coils of long wire with a small galvanic element it was not found to answer. Dr. Beck also constructed a horseshoe of round iron one inch in diameter, with four coils on the plan before described. With one wire it lifted 30 lbs., with two wires 60 lbs., with three wires 85 lbs., and with four wires 112 lbs. While we were engaged in these investigations, the last number of the *Edinburgh Journal of Science* was received containing Professor Moll's paper on 'Electro-Magnetism.' Some of his results are in a degree similar to those here described; his object, however, was different, it being only to induce strong magnetism on soft iron with a powerful galvanic battery. The principal object in these experiments was to produce the greatest magnetic force with the smallest quantity of galvanism. The only effect Prof. Moll's paper has had over these investigations has been to hasten their publication; the principle on which they were instituted was known to us nearly two years since, and at that time exhibited to the Albany Institute.\*

(To be continued.)

## POLARISATION OF THE EARTH BY HEAVY CURRENTS.†

By CHARLES CUTTRISS.

WHILE investigating further the causes of the disturbances experienced when testing the Commercial Cable Company's cable which lands at Coney Island, an account of which will be found in the *Electrical Engineer* of August 6th,‡ certain phenomena have been noticed which may be interesting as showing the effect



"Experiment 16.—In order to ascertain the effect of a very small galvanic element on this large quantity of iron, a pair of plates, exactly one inch square, was attached to all the wires; the weight lifted was 85 lbs.

"The following experiments were made with wires of different lengths on the same horseshoe.

"Experiment 17.—With six wires, each 30 feet long, attached to the galvanic element, the weight lifted was 375 lbs.

"Experiment 18.—The same wires used in last experiment were united so as to form three coils of 60 feet each; the weight supported was 290 lbs. This result agrees nearly with that of experiment 11, though the same individual wires were not used; from this it appears that six short wires are more powerful than three of double the length.

"Experiment 19.—The wires used in Experiment 10, but united so as to form a single coil of 120 feet of wire, lifted 60 lbs.; while in Experiment 10 the weight lifted was 200 lbs.; this is a confirmation of the result in the last experiment.

"In these experiments, a fact was observed which appears somewhat surprising; when the large battery was attached, and the armature touching both poles of the magnet, it was capable of supporting more than 700 lbs., but when only one pole is in contact it did not support more than 5 or 6 lbs., and in this case we never succeeded in making it lift the armature (weighing 7 lbs.). This fact may perhaps be common to all large magnets, but we have never seen the circumstance noticed of so great a difference between a single pole and both.

"A series of experiments was separately instituted by Dr. Ten Eyck, in order to determine the maximum development of magnetism in a small quantity of soft iron.

"Most of the results given in this paper were witnessed by Dr. L. C. Beck, and to this gentleman we are indebted for several suggestions, and particularly that of substituting cotton well waxed

of heavy currents in polarising the ground when it is used as a return circuit for an electric road, and also the great distance at which such effects are felt.

On Sunday, August 17th, an attempt was made from my office in the Drexel Building, New York, to take the usual weekly test of the condition of the cable, but without success, as, owing to the violent and erratic movements of the mirror, it was impossible to get a reliable reading. It was then determined to measure, if possible, the differences of potential that caused such disturbances. In order to make the method of procedure clear, it will be well to state that the underground circuits of the company extend from Wall Street in a northerly direction to the Bronx River, a distance of about 12 miles, and in a southerly direction to Coney Island, also about 12 miles. As there is nothing to my knowledge in the vicinity of the Bronx River terminus to cause any electrical disturbance of the earth's potential, the grounding at that station and at Coney Island of one of their wires gives a very ready way of detecting in New York any variations of potential that may take place at either end.

The first series of experiments were made between

\* Scientific Writings of Joseph Henry, p. 49.

† *Electrical Engineer*, of New York.

‡ See *ELECTRICAL REVIEW* for August 22nd.

the hours of 10.45 a.m. and noon of August 17th, and showed that between Bronx River and New York there was a fairly steady difference of potential of from .8 to 1 volt; but between New York and Coney Island there was a difference of potential varying rapidly from .1 to 3.5 volts, the extreme fluctuations often occurring in four or five seconds. The potential difference between Bronx River and Coney Island was about the same as between New York and Coney Island, or perhaps a trifle higher, and also very unsteady.

It was useless to do anything more until the electric road closed down, so the experiments were abandoned till midnight. At 12.25 a.m. I found a very heavy current between Coney Island and New York, but could not detect the running of any cars. Measurements now showed a positive difference of potential of 4.5 volts; this remained fairly steady till about 1 a.m., when the potential commenced to fall slowly and steadily. At 1.15 a.m. the galvanometer denoted an equal potential at both ends of the line, but the movement of the mirror still continued, slowly crossing the zero and indicating an opposite, or negative, potential wave, which by 1.25 a.m. had reached 3.5 volts negative. It then began to drop, reaching zero at 1.40 a.m., and continued on until it showed a positive difference of .8 volt, where it remained steady, showing that the earth at Coney Island had become normal, as the difference of .8 volt corresponded with the reading between New York and Bronx River. I might state that the New York ground potential was checked off by the Bronx River circuit every five minutes in order to make sure that the variations were not due to local causes.

From the results obtained in the above experiments it is quite evident that there is an actual polarisation of the ground for an unknown distance from the rails of the electric road. The accompanying diagram will make clear the relative positions of the electric road and the ocean cable. The first long, positive (+) current, I think, must be caused by a direct flow of current from the rails through the sea and across the marsh and Sheepshead Bay to the sheathing of the cable; consequently, when the current is cut off from the rails, this direct current gradually drops, and as the current due to the polarisation asserts itself, for an instant the ground at the point of connection between the conductor and sheathing becomes neutral from the action of equal and opposite forces. But, as the negative current from the ground surrounding the cable discharges along the sheathing, that being the path of least resistance, it produces a negative potential at the end of the conductor, which rises to a maximum in a few minutes, and then gradually dies away as the condition of the ground becomes normal. If the normal condition of the ground can thus be raised 4.3 volts by a disturbing force at a distance of  $\frac{1}{2}$  mile, the close proximity of these two systems would certainly render the practical working of the weaker one—the cable—almost an impossibility, even if, as suggested by Mr. T. D. D. Lockwood, a duplicate cable were to be laid, as it is mechanically impracticable to construct two cables in which the dielectric resistance, copper resistance, and capacity shall be identical. Consequently, a variation in either of these respects must make itself manifest when the cores are subjected for a considerable distance to violent and rapid electrical strains.

The great difference in this problem over that of equalising telephone or telegraph circuits rests in the extreme delicacy of the receiving apparatus, and the enormous electrostatic capacity of long lengths of submarine cable.

**New York Subway Work.**—The Board of Electrical Control met on August 22nd, in the Mayor's office, and received a report from the Construction Company, which shows the work of burying the wires is going on satisfactorily. The report states that, in 1889, 56,035 feet of subway and 621,430 feet of ducts were laid. Up to the month of August, 1890, 158,181 feet of trench have been dug, and 774,926 feet of ducts laid.

## NOTES.

**The Bradford Corporation Lighting.**—At the meeting of the council, last week, in reply to a question about the electric lighting work, Alderman Priestman said, with regard to the electricity works, that he had given a statement of the loss accrued to December 31st last, and he hoped to present a statement at the end of the present year. So far, the loss was short of £1,000. The electrical department had never been expected to pay in its earlier stages. An engine was now being laid down which would increase the output without augmenting the working cost, and he expected that in a few months the statement would be very much better than it would be if presented now. If the council would appropriate a sum of, say, £10,000 from the profits of the gas department for the benefit of the electric lighting works, they could be made to pay their way. With regard to the mains and services, which stood at the large sum of £177,000, he believed they had value for every penny of the money. He hoped that ere long the committee would be able to show that the electric lighting department was paying its way; but if not, it would be necessary to raise the price to the consumer. There was no cause to regret the steps taken in respect to this question. He had not the least doubt that if they had not taken the powers of supply themselves, they would have had to spend a great deal more money in keeping other people out. The minutes were then adopted.

**Electric Lighting at Fareham.**—The completion of the electric lighting installation at Fareham was celebrated on Thursday evening by a banquet, which was given by Capt. Ramsay and the directors of the local electric lighting company to the principal residents of the town and neighbourhood. The dining-room at the Red Lion was lighted in honour of the occasion by numerous small incandescent lamps, which hung from the ceiling. The street poles, with regard to which an indictment is pending against the company, have been adorned with paint, and can no longer be said to constitute an eyesore, while the lighting by electricity of the main thoroughfares has given general satisfaction to the inhabitants.

**Portsmouth and the Electric Light.**—No definite steps have yet been taken with regard to the introduction of the electric light into Portsmouth by the Corporation, but the committee recently appointed is engaged in collecting information which will be embodied in its report to the council. In all probability the Corporation will decide to obtain its own provisional order, and afterwards sub-let its rights for a short period to the highest bidder among the rival electric companies who are anxious to make a start in the town, but have hitherto been foiled by the "dog-in-the-manger" policy of the municipality. It is whispered that some time since an effort was made to induce the directors of the Portsmouth Gas Company to take up electricity, but they declined, and now it is too late.

**Church Lighting.**—An installation of the electric light is at present being carried out at the Church and Parochial Hall of St. John's the Divine, Vassall Road, Brixton. About 300 incandescent lamps will be used. The plant consists of a gas engine, a dynamo, and a set of accumulators; a motor is also being put down for blowing the organ of the church electrically.

**Electric Lighting at Barnsley.**—The Barnsley Corporation have adjourned the matter of the electric light to enable the Thomson-Houston Company to send in a complete tender. It is probable that although that of the Westinghouse Company was accepted the contracts may not be signed. Several members of the committee have recently visited various central stations, and are so favourably impressed with the Thomson-Houston system that it seems likely that it will prevail.

**Prague Electric Lighting.**—At the end of last year the electric lighting installations in Prague comprised 8,365 incandescence lamps and 143 arc lights, distributed among various factories, theatres and restaurants. The current was obtained from 47 dynamos of a total capacity of 425 kilowatts. Steam engines and gas engines supplied the motive power, the gas engines being in the proportion of 23 per cent.

**Faraday & Son.**—The firm of Faraday & Son, of Berners Street, was one of the first to devote special attention to the production of decorative fittings suitable for lighting by electricity. Their book of designs has gradually grown in size, and the new edition, now being issued, consists of 62 pages of drawings representing brackets, pendants, electroliers, coronæ, standards, figures, hall lanterns, portable lamps, and billiard lights, the registered designs of which, numbering nearly 100, are the property of the firm.

**Holden & Brooke.**—Messrs. Holden and Brooke, of Manchester, have issued a new catalogue, containing several new specialities and the latest developments in exhaust and live steam injector practice. It also gives a series of self-explanatory drawings of injectors fitted up under various conditions, with such instructions as would enable purchasers abroad to know exactly what to order for their requirements.

**Britannia Company.**—We have received catalogue No. 3 from the Britannia Company, consisting of descriptions, illustrations and prices of engineers' tools and amateurs' lathes. The prices, however, are modified by the notice (which so frequently accompanies trade lists now-a-days) that, in consequence of the continued advance in the cost of raw material and wages, all quotations and discounts are from this date withdrawn.

**W. T. Goolden & Co.**—This firm has issued a useful little pamphlet, entitled "Electricity in Every-day Life," explaining the advantages of electric lighting and the transmission of power by electric motors for pumping, ventilating, hoisting, drilling, and a variety of other operations. The illustrations are all representations of appliances that have been actually constructed and set up, and that have proved perfectly successful under ordinary working conditions.

**Sunbeam Lamp.**—A new price list is issued of the sunbeam lamp, which has been found in practice to be specially adapted for lighting large halls, exhibitions, saloons and decks of ships, and similar places. It is pointed out that, with the same engine and dynamo power, nearly double the light can be obtained from this lamp, as compared with groups of small glow lamps; and, compared with arc lamps in opal globes, the sunbeam gives nearly two-thirds the light, is absolutely steady (never falling momentarily in brightness, as does the arc), requires no attention, and is pleasanter in colour.

**Phosphor-Bronze Company.**—We have been favoured with an early copy of the latest descriptive catalogue and pamphlet issued by the Phosphor-Bronze Company. It is stated in the introduction that the company's cog-wheel brand of alloys of phosphor-bronze have been in extensive use for 20 years. The use of phosphor-bronze wire, and especially of Weiller's patent silicium-bronze wire, for telegraph and telephone purposes, has been attended with the most important results, especially as regards the danger of overhead wires and the cost of renewals. Long telegraph lines, for which iron wire, weighing 400 lbs. per mile, was formerly used, is replaced by bronze wire weighing only 100 lbs. per mile, while for telephone lines bronze wire of 38 lbs. per mile has been used where formerly the wire weighed 240 lbs. per mile. The wire being smooth and light, and offering very little surface to wind and snow, is unaffected by the severest storms, so that its use does away with the danger of falling wires and the inconvenience of interrupted communication.

**Electrical Tramways at Boston.**—The West End Electrical Tramway of Boston, U.S., is the largest system, worked by electricity, in the world. There are about 260 miles of line, with 1,600 cars. Until recently these tramways were worked by horses, but experiments in electric traction, carried out by the Thomson-Houston Company, resulted so satisfactorily that horses were done away with altogether, and electricity substituted in their place. The station is the largest electrical one existing, the boiler-house being 160 feet in length by 80 feet in width, and the dynamo room about twice these dimensions. There will be 13 Corliss engines of 1,750 H.P. each, driving 300 H.P. dynamos. The wires are overhead, and it would surprise those who object to this method on the ground of unsightliness to know how little the wires and poles are noticeable.

**The Schanschieff Electric Light and Power Company, Limited.**—Notice is given, that a general meeting of the members of the above-named company will be held at 32, Poultry, at two o'clock, on 17th October next, for the purpose of having the accounts of the liquidation, showing the manner in which the winding up of the affairs of the company has been conducted, and the property of the company disposed of, laid before the company, and hearing any explanation that may be given with reference thereto; and for the purpose of considering such accounts, and, if the same shall be approved, of passing a resolution approving the same; and also of determining, by extraordinary resolution, the manner in which the books, accounts, and documents of the company, and the liquidation thereof, shall be disposed of.—S. DE LISSA, liquidator.

**Australian Cable.**—It is stated by the Press Association that Lord Knutsford has addressed a letter, dated July 9th, to the Governor of South Australia, setting forth the reasons why Her Majesty's Government have refused to comply with the request of the Australian Governments that the Imperial Exchequer should bear a share of the guarantee and subsidies which are necessary to allow the cable companies to reduce their rates to Australia. The letter states that the Agents-General have very fully explained, and have ably supported, the views of their Governments in this matter. The Imperial Government fully sympathise with the object of the subsidy, and recognise the nature and extent of the sacrifices which the Australian colonies are prepared to make with a view of developing and facilitating telegraphic communication. The readiness with which the colonies accepted, at the risk of considerable loss of revenue, the proposal of the Chancellor of the Exchequer for a reduction of the postal rates affords additional reason for the most favourable consideration of any proposal emanating from their incognate matters.

**American Electric Transit Statistics.**—The Census Bureau of America has issued a bulletin which gives interesting information as to transit facilities of the country. The relation between electricity and other motive powers shows the former to have reached a fairly good figure. The figures run:—

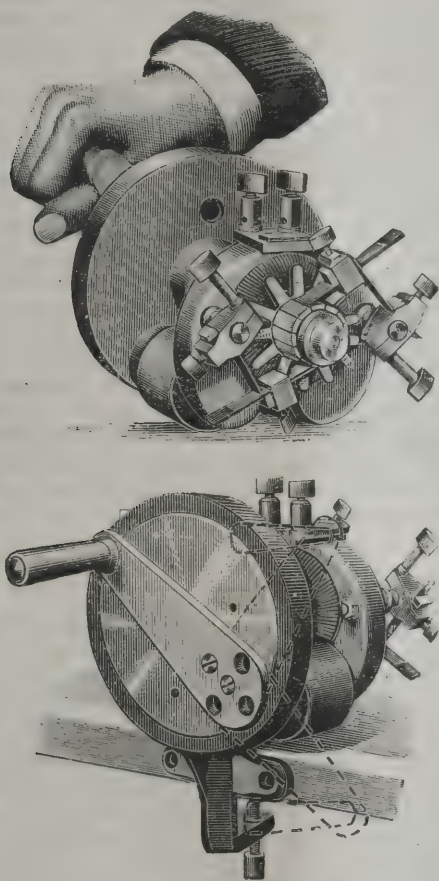
Miles of horse railway ...	...	5,902½
" electric ...	...	1,753
" dummy ...	...	556
" cable ...	...	441
Total mileage...	...	8,652½

Electricity has, therefore, more than 25 per cent. of the total mileage.

**Appointment.**—Mr. Edward A. O'Keeffe, B.E., has been appointed Senior Demonstrator and Lecturer at the City and Guilds of London Technical College, Finsbury, in the place of Mr. W. Robinson, the newly-appointed Professor of Engineering at University College, Nottingham.

**Lectures on Electric Meters.**—A course of six lectures on electric meters, by Prof. Silvanus Thompson, is announced to commence in October at the Finsbury Technical College. This is one of the occasional short courses of lectures which each of the Finsbury professors undertakes annually. The electric lighting arrangements of the college have been lately overhauled and improved. A new Kapp dynamo has replaced the Edison machine formerly employed.

**Austin's "Novel" Hand Dynamo.**—This hand-dynamo has been specially designed for experimental work, either in the laboratory or on the lecture table, for which it is admirably adapted, as from the manner in which it is wound, it will work under all circumstances; no matter whether the external resistance be high or low, the machine will give out a corresponding quantity of current. Great care has been taken in the construction of these machines, so that as much as possible of the manual work expended in turning the



handle is given out at the terminals as electrical energy. As will be seen from the illustrations, the machine is very compact, and has a pleasing appearance. Its output is equal to about six or eight quart Bunsen cells. The machine all complete weighs only 16 lbs. It can be fixed either temporarily or permanently to bench or table. Six different leverages can be got by altering position of handle, three of the most important being shown by dotted lines. There are no belts, cords, or cogwheels used in gearing, which is constructed entirely of metal, working on the principle of rollers and traction—there is consequently very little friction. There are no complicated parts, every part being constructed in the simplest manner possible, and the material and workmanship are of the best.

**The Loan for Electric Lighting at Dublin.**—Mr. Charles P. Cotton, C.E., Board of Trade Inspector, held an inquiry at Dublin last week with reference to an application of the town authorities for a loan of £50,000 for the purpose of an installation for the supply of electricity. The inspector is preparing a report on the evidence.

**Killed by Electricity.**—The *Times* New York correspondent says:—A terrible electric light accident occurred at a theatre here on Monday night. While a lineman was adjusting some wires for illuminating the front of the theatre, he accidentally established a connection, and, receiving the full force of the current, was killed on the spot. The accident caused a most painful impression among a large number of persons who were watching the man's operations.

The *Evening News and Post*, in referring to this matter, says:—"The circumstances will tend strongly to discredit the new system of execution in that State."

"The fact that such torture as this man suffered is possible for a full ten minutes without life being extinguished, shows that electricity is not to be relied upon as a painless method of killing." Surely our evening contemporary does not imagine that the process of electrical execution is to suspend culprits from wires, and let them roast? Moreover, the incidents peculiar to this case had happened previously to Kemmler's fate, so it is rather late in the day to pen comments of this nature.

**The Telephone on the Congo.**—The *Ville de Maranhão*, of the Walford Company of Antwerp, which has just sailed for the Congo, carries all the material necessary for the installation of the first telephone line which is to be placed along the Congo railway. The wires are of phosphor-bronze, and the apparatus is on the Dejongh system, made by Mourlon, of Brussels, with magneto bells of the model adopted, after a competition, by the Administration of Belgian Posts for its private lines, &c.

**Stockholm Electric Lighting.**—The following circular has been sent to members of the Electrical Trade Section of the London Chamber of Commerce by the secretary:—"Having been advised that the notice which appeared in the electrical papers, that the date for the presentation of tenders for the lighting by electricity of the town of Stockholm had been extended from the 15th September to the 12th October, was erroneous, I have, at the request of the chairman of the Electrical Section, and after consultation with the Foreign Office and the Swedish Consul in London, communicated officially with the Stockholm Gas Works. In reply, I have received official telegraphic intimation from that body in language which is considered sufficiently satisfactory, that tenders for the electric lighting contract at Stockholm, *posted from this country not later than the 20th inst., will be considered.*"

**Charterhouse Science and Art Schools and Literary Institute.**—The winter session of this, one of the largest Science and Art Schools in the United Kingdom, and a school which has trained some thousands of teachers for the office of science lecturers, will commence on Saturday, September 27th, 1890, under the presidency of the Rev. Henry Swann, M.A. During the late session about 900 students, mostly elementary teachers, availed themselves of the privileges afforded by this institution, and of this number above 700 presented themselves for examination, and were successful in obtaining a large number of first-class certificates, and also several honors' certificates awarded by the Science and Art Department of South Kensington. Students who were prepared for the Lond. B.Sc. (Inst.) highly distinguished themselves. A National Scholarship of £150 was awarded to one of the female students of the Art school. Instruction of a practical character is given in most of the sciences at a very nominal fee. Students who aim at becoming proficient in chemistry (organic and inorganic) have the opportunity of working in a well-fitted laboratory, capable of accommodating 60 students. Full particulars of the classes may be obtained from C. Smith, organising secretary.

**The Electric Light in Textile Factories.**—In a recent number of *L'Electricien* the arrangement of the electric light in spinning and weaving mills is discussed. For spinning white, unbleached, or clear-coloured yarns in high rooms, the proportion is given of one 12-ampère arc light to 230 square yards, that is 15 by 15 yards. For a 9 or 10-ampère arc the area should not exceed 110 square yards, or  $10\frac{1}{2}$  by  $10\frac{1}{2}$  yards. For weaving, a minimum lighting power of a 12-ampère arc to 133 square yards, or  $11\frac{1}{2}$  by  $11\frac{1}{2}$  yards, is given. For white, unbleached, or clear colours, a 10-ampère arc should be sufficient for an area of 93 square yards, say  $9\frac{1}{2}$  by  $9\frac{1}{2}$  yards; but for black, or dark colours, it is often found necessary to allow only 59 square yards for each 10-ampère arc. In weaving light goods by incandescence lamps, a 10-candle lamp may be used for two looms with unbleached stuff, but when working in coloured yarns two 16-candle lamps are required per loom, and should this be a long one, two 20-candle lamps. These figures appear to be taken from actual experience in Belgium and Germany, but as nearly every factory has a different arrangement of rooms and machinery, the amount of lighting required will not depend so much upon the area of the rooms as upon the method necessary to sufficiently illuminate each particular machine or separate portion of work.

**Elmore's French Patent Copper Depositing Company, Limited.**—This company has been formed to work the process of the Messrs. Elmore in France, with a capital of £200,000 in 100,000 shares of £2 each. 66,750 shares were offered to the public at a premium of 10s. per share. The board of directors includes Sir Richard J. Meade, Major Charles Jones, E. J. Carson, Wm. Elmore, Charles Glendinning Philips, and Sir James D. Mackenzie, Bart. The patents were to be sold to this company by Elmore's Foreign and Colonial Patent Copper Depositing Company for £83,500 cash, £66,500 in shares, and the premiums on the shares (assuming the shares were all taken up), amounting to £33,275, the vendors thus benefiting to the extent of £183,275. The working capital will be £50,000.

**Fraud by a Telegraphist.**—Herbert Wadsworth, assistant postmaster at Milnsbridge, was fined £2 and costs by the West Riding magistrates at Huddersfield on Monday, in each of two cases for wilfully and without due authority altering telegrams with intent to defraud Her Majesty's Postmaster-General. In consequence of complaints as to alterations of telegrams going from this office, a clerk from London was sent on August 28th to make inquiries. This gentleman handed in two telegrams at the Gobar office addressed to different people in Bradford, and containing 58 words. Upon these 2s. 5d. was paid. Defendant condensed messages, and by sending them as duplicates only, placed 1s.  $3\frac{1}{2}$ d. upon them in stamps, pocketing the difference.

**The American Association for the Advancement of Science.**—Professor Nipher is credited with having described a new method of measuring the electrical resistance of liquids before this Society (see page 339). We would like to ask wherein this differs from that devised years ago by Wheatstone, whose apparatus also reversed the galvanometer at the same time? This so-called new method appears to be periodically revived, as we have previously pointed out.

**Blasting by Means of Electricity.**—The work of blowing up the masses of rock which form the dangerous rapids known as the Iron Gates, on the Danube, was commenced on Monday near Greben, M. Baross, the Hungarian Minister of Commerce, firing the first charge by means of electricity.

**The Telegraph in the Chin-Lushai Expedition.**—His Excellency the Governor-General of India, in Council, is glad to acknowledge, through a general order dated September 8th, 1890, the services of Mr. E. O. Walker, Assistant-Superintendent of Telegraphs, and his department, and of Mr. G. Barton Groves, Deputy Inspector of Post Offices, and the Postal Department.

A despatch of the Adjutant-General in India, dated July 16th, states:—The Telegraph Department worked extremely well throughout the expedition.

Lieut.-General B. L. Gordon, C.B., commanding the Burnia district, in a despatch to the Adjutant-General, Madras, dated May 28th, says:—The Telegraph Department has worked well, under many difficulties of transport labour and sickness. The construction of the line kept pace with the advance of the troops into Haka. The wire has been invaluable throughout the operations.

In a despatch dated 31st May, addressed to the Adjutant-General, Brigadier-General V. W. Tregear, commanding the Chillagong column, states:—The whole of the field work has proved laborious and exhausting to all concerned, owing to steep ascents and declivities, and the dense forest and undergrowth, or bamboo jungle, everywhere met with. The whole of the work has, notwithstanding these difficulties, been carried out in a most excellent manner, and reflects the greatest credit on Mr. Walker and all his subordinates. Owing to ill-health, Mr. Walker had to return to India on the 7th March from Fort Tregear, after which date the laying of the line was carried on by Messrs. Rector and Davies, both of whom have worked very hard and well throughout the expedition; the services of the latter officer I had the pleasure of bringing to notice in my final report on last year's expedition. The construction of the line from Fort Lungleh towards Haka was commenced simultaneously with the road, and by the 23rd March had been completed to the Upper Kolodyne, a distance of 65 miles, when orders were received to discontinue the laying of the line towards Haka till next winter, when it can be carried out in a permanent manner.

**A Novel Telephonic Reaction.**—The New York *Electrical Engineer* says:—"We have recently had our attention called to an interesting phenomenon in connection with the telephone, which might be looked upon with suspicion by the uninitiated. While Messrs. Hibbard and Pickernell were conversing recently over one of the lines of the Long Distance Telephone Company, the former, in order to shut out some conversation, placed the receiver with the diaphragm end over the mouthpiece of the long-distance transmitter. The receivers at both ends at once began to give out at musical sound, which continued until the receiver was withdrawn from the mouthpiece of the transmitter. Investigation proved that the effect was due to an action quite similar to that employed in the well-known buzzer, or vibrating bell. An original impulse imparted to the transmitter is conveyed electrically through the primary and secondary circuits to the receiver, which in turn throws it back upon the transmitter through the intervening air, thus constituting a complete electric and acoustic cycle. This battledore and shuttlecock action between receiver and transmitter is continuous as long as the receiver is held against the transmitter, and gives rise to a musical note of high pitch and great uniformity. Of course, it requires a powerful transmitter to produce the phenomenon, the ordinary Blake instrument being incapable of demonstrating it. The effect produced is decidedly novel, and the experiment is well worthy of repetition." We may remark that the experiment is not novel, a precisely similar one having been made several years ago by Mr. Ströh, in the early days of the telephone and microphone; the microphone used was of small dimensions, and was mounted on a diaphragm of gold-beater's skin.

**Personal.**—We understand that Mr. Albright sails tomorrow in the *Servia* with the members of the Iron and Steel Institute, who are about to visit America.

### NEW COMPANIES REGISTERED.

**Elmore's French Patent Copper Depositing Company, Limited.**—Capital £200,000 in £2 shares. Objects: To adopt an agreement between Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, of the first part, Woodhouse & Rawson United, Limited, of the second part, and this Company of the third part. To carry on in France, and elsewhere, the business of manufacturers of and dealers in copper and other metals, all metallic alloys or compounds of the same, and all goods or articles made of copper or other metals and alloys. To carry on business as electricians, electrical contractors, electrical and mechanical engineers, and suppliers of electricity for the purposes of light, heat, sound, power or otherwise, and of manufacturers of and dealers in all apparatus and things required for the generation, distribution, supply, accumulation and employment of electricity. Signatories (with one share each), A. L. Brockman, 8, The Avenue, Brondesbury; T. E. Marsh, 42, Reighton Road, Upper Clapton; J. North (engineer), 88, Queen Victoria Street; S. Rentall, 121, Vassall Road, Brixton; J. Mumford, 50A, Trinity Square, Borough; J. Moore, 46, Norroy Road, Putney; F. Dewar Summers, 31, Berwick Street, S.W. The signatories are to appoint the first directors. Qualification: 200 shares, or £500 stock. Until otherwise determined by the company in general meeting, the remuneration of the board is to be £200 per annum for each director, with an additional £200 per annum for the chairman, and £100 for the vice-chairman, together with 2½ per cent. commission upon the net profits from manufacturing and upon the revenue accruing from licensing or sub-licensing the Company's patents, and 1 per cent upon net profits from sale of patents, such commission to be divided as the directors think fit. Registered 10th inst. by Wm. Brown, 18, St. Swithin's Lane, secretary.

**Service and Company, Limited.**—Capital £6,000, in £5 shares. Objects: To acquire the business of wholesale and retail ironmonger, carried on at 4, The Octagon, Plymouth; to carry on (if thought wise) the business of an electric light company in all branches, and to supply electricity for light, heat, motive power, or otherwise; and to manufacture and deal in electrical apparatus generally. Signatories (with 1 share each): W. H. Luke, F. S. Willies, A. Yeo, A. N. Cole, T. B. Percy, all of Plymouth; J. Snawdon, Pennycomequick; R. W. C. Barker, Stonehouse. The remuneration of the directors is to be determined by the company in general meeting. Qualification: £125 in shares. Registered 10th inst. by Sir Joseph Causton and Sons, 9, Eastcheap, as agents for Bond and Pearce, Solicitors, 16, Princess Square, Plymouth.

### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Electric Installation and Maintenance Company, Limited.**—An agreement of 25th ult., filed 12th inst., cites that the Electric Construction Corporation, Limited, has carried out an electric installation at Nos. 19 and 20, Walbrook, and is supplying electricity to various customers in the neighbourhood. This company agrees to purchase the said installation and the plant, materials, &c. in connection therewith, for £2,390, payable as to £950 in 6 per cent. debentures and the balance by the allotment to the vendor company of 144 fully paid £10 shares in this company.

**Syndicate of Electrical Engineers, Limited.**—The statutory return of this company, made up to the 7th February, was filed on the 8th ult. The nominal capital is £10,000, divided into 1,900 ordinary and 100 founders' shares of £5 each. 607 shares have been taken up, and the full amount has been called thereupon. The calls paid amount to £600, and unpaid to £7. Registered office, 15, St. Helen's Place.

**Earthy Metals Company, Limited.**—The registered office of this company is at No. 1, Westbourne Terrace, Willesden Green.

**Mulholland, Maugham & Company, Limited.**—The registered office of this company is situate at West Cornforth, R.S.O., Ferryhill, Durham.

**Edison Photographic Toy and Automaton Company, Limited.**—The registered office of this company is at 2, Metal Exchange Buildings, Gracechurch Street.

### CITY NOTES.

#### The Electric and General Investment Company.

THE first ordinary general meeting of this company was held on Tuesday afternoon last, at the offices, Nos. 1 and 2, Great Winchester Street, Old Broad Street, under the presidency of Mr. John Herring.

Mr. J. Cecil Bull (the secretary) read the notice convening the meeting, which stated that it was merely a statutory meeting held in accordance with the requirements of the Companies' Acts, and that there would be no business transacted.

The Chairman remarked that although it was only a formal statutory meeting, it was usual for something to be said on such occasions, either as to the business actually done by the companies or their prospects. He was able to state that the directors had had brought under their notice a considerable number of schemes, some of which looked good, whilst others the board had dismissed as not worthy of their consideration. Two or three of the schemes presented a more than ordinarily favourable outlook. If any one of those schemes turned out successful for the company, it must, with its limited capital, prove of very great advantage to the shareholders. Up to the present, the company had not done any actual business, for they were in a quiescent position. The directors had been very economical in every respect, and had so dealt with the capital as to keep down the expenses in every way possible. In fact, he believed he might with confidence state, that that was one of the cheapest companies ever formed, and the expenses had been confined to a very small outlay, and the capital had been lent out upon good and approved securities in order to bring in interest, so that it should not be lying idle. Therefore, if they took away the amount of the preliminary expenses for the formation of the company, the interest which they were earning on the money paid their expenses, so that their capital was left intact. There was a great deal of business in front of them which might, or might not turn out to be for the benefit of the company. At any rate, the directors had very great hopes. The chairman concluded by giving some particulars as to the arrangements for office and other expenses with the view of keeping down the expenditure as much as possible.

Mr. E. Garckie (director) also corroborated the chairman as to the number of schemes which had been submitted for the consideration of the directors and added, that, of course, the future of the company depended almost entirely upon the development of the electric industries.

**The Woodhouse and Rawson Electric Contract and Maintenance Company, Limited.**—Creditors of the company are required, on or before the 11th day of October, 1890, to send their names and addresses, and the particulars of their debts or claims, and the names and addresses of their solicitors (if any), to Gustavus Adolphus Steinthal, of No. 41, Piccadilly, Bradford, in the county of York, the liquidator of the said company, or in default thereof they will be excluded from the benefit of any distribution made before such claims are received.

**The Direct Spanish Telegraph Company, Limited.**—The board has decided to recommend the payment of the dividend at the rate of 10 per cent. on the preference shares, and a dividend at the rate of 6 per cent. (free of income tax) upon the ordinary shares for half-year ended 30th June last.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 12th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,698.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (September 11.)	Closing Quotation. (September 18.)	Business done during week ending September 18, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	98 — 101		
1,549,160	Anglo-American Telegraph, Limited	Stock	51½ — 52½	51½ — 52½	51½	51
2,725,420	Do. do. 6 p. c. Preferred	Stock	88 — 87	88 — 89	88½	88
2,725,420	Do. do. Deferred	Stock	15½ — 16	15½ — 15½	15½	...
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12½	11½ — 12½	12½	12
99,000	Do. do. 5 p. c. Bonds	100	100 — 102	100 — 102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1896	100	103 — 107	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 2	1½ — 2		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 1½xd	1½ — 1½xd		
\$7,216,000	Commercial Cable, Capital Stock	\$100	103 — 105	103 — 105		
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	5½ — 5½	5½ — 5½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,000	Cuba Telegraph, Limited	10	12½ — 13	12½ — 12½		
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	17 — 18		
12,931	Direct Spanish Telegraph, Limited (£4 only paid)	5	3½ — 4½	4 — 4½		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½	14 — 14½	14½	13½
70,000	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15½	...
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	108	...
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	105 — 108	104 — 107		
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½	14½ — 14½	14½	14½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102	100½	...
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106	103 — 106		
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	103 — 106		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	102 — 105	102 — 105	102½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8½	7½ — 8½		
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	7½ — 8½	6½ — 7½	8	6½
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 (£3 only paid)	5	3 — 3½	2 — 2½		
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9	8½ — 9½	9½	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15	14½ — 15	15	14
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	15½	...
40,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103	100 — 103		
250,000	Do. do. do. (issue of 1883)	100	104 — 107 xd	104 — 107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 — 19	18½ — 19½	19½	19
200,000	Do. do. 4½ p. c. Deb., 1896	100	102 — 104	102 — 104		
17,000	Indo-European Telegraph, Limited	25	36 — 38	36 — 38	37½	36
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6½ — 7½		
100,000	Do. do. do. 6 p. c. Debentures	100	105 — 108 xd	105 — 108		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4 — 4½	4 — 4½		
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4½ — 4½	4½ — 4½	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½		
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	10½	10
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	½ — ½	½ — ½		
9,000	Reuter's, Limited	8	8 — 8½	8 — 8½	8½	8½
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, } 2,501 to 3,500, 93,251 to 300,000 }	1	½ — ½	½ — ½		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3		
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117	117	...
78,949	Swan United Electric Light, Limited (£3½ only paid)	5	5 — 5½	5½ — 5½	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43½	43
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
55,000	United River Plate Telephone, Limited	5	3½ — 4	3½ — 4		
146,000	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94		
100,000	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10		
300,000	Do. do. do. 5 p. c. Debentures	100	99 — 102 xd	99 — 102	100½	...
30,000	West Coast of America Telegraph, Limited	10	4½ — 5	4½ — 5	4½	...
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	101 — 106	101 — 106	104½	103½
64,572	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11½	11
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 7½	6½	6½
26,986	Do. do. do. 5 p. c. Deferred	7½	4½ — 5	4½ — 5	14½	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106		
250,000	Do. do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 — 104	101 — 104		
88,321	West India and Panama Telegraph, Limited	10	3 — 3½	3½ — 3½	3½	3½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 12		
4,669	Do. do. do. 6 p. c. 2nd Preference	10	13½ — 14	13½ — 14		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	122 — 127		
119,300	Do. do. do. 6 p. c. Sterling Bonds	100	97 — 99 xd	97 — 99		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 1½	1½ — 1½		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7 — 7½.—Elmore Wire, ½ dis.—par.—House-to-House Company (£5 paid), 5 — 5½.—International Okonite, Ordinary of £10 (£7 paid), 6½—7½ London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/- — 13/-.

## WINE AND ELECTRICITY.

[FROM A CORRESPONDENT.]

IN an article of your issue for August 29th, headed "Electricity is Life," you spoke of its use for the improvement of spirituous liquors. This well-meant proposal has formed the subject of careful discussions in Hungary, rich as it is in wines, and it has even culminated in tangible proposals, though of very doubtful value.

Baron von —, a writer on economical subjects, discussed this question at some length in a leader in the *Pester Lloyd*, a journal of a very wide circulation. He wrote:—"One of the most recent advances in the utilisation of electric energy is that of the electrolysis, or decomposition of liquids by means of the electric current. We can scarcely err if in this direction we entertain very bold expectations, and assume that new tracks of unexpected importance for practical life will be opened in this direction. Without doubt, agriculture and its connected arts will derive essential advantages from such inventions and discoveries. The electrolytic purification of sewage seems, as far as it can be ascertained, to be a matter of certainty, and justifies the most sanguine expectations. The question of the general de-fuselising of spirits by means of electrolysis is on the very point of solution, and the same is probably the case with the improvement of wine by the introduction of an electric current."

After a brief historical survey of the recent scientific investigations in this field, the writer of the article continues:—"For this new and promising process we are indebted to the American, Fraser. He takes a different method from that adopted by earlier experimentalists. Whilst they all conducted the current directly into the wine, and thus doubtless produced an effect which might be considered as too much of a good thing, Fraser only allows the electricity to act indirectly. He procured casks about 3 metres in length and  $\frac{1}{4}$ th metre in diameter, and were thus more like a wide pipe than a common cask. He covered the casks with coils of wire, just like the wrappings of an electro-magnet, and passed a strong electric current without interruption through the wires for 10 days. The casks were filled, some with different sorts of wine and others with freshly-distilled raw spirit. At the expiry of the 10 days, the casks had such a strong electric charge that, on touching them, strong electric shocks were experienced! The wine had deposited all its albumenoid matter and had assumed the colour and the bouquet of a fully-matured, ripened product, so as to be already in a merchantable condition. This electrified wine was further distinguished by its great permanence, as if it had been submitted to the Pasteur process. As for the brandy, it had likewise been advantageously modified by the electric treatment, and had acquired the flavour and the aroma of an old spirit many years in cask."

"In presence of such striking results, companies have been already formed in California for introducing the Fraser process on a large scale. It cannot be denied that the above experimental results may be of the greatest practical importance, both for producers of and dealers in wines and spirits. It is unnecessary for us to call the attention of our readers to the enormous pecuniary results which would accrue were it in the power of every dealer to transform his wines within a few days from a crude product to one fully matured and fit for bottling, and to give fresh brandy the flavour of an old product, rich in bouquet."

"Any one who feels an interest in this important question can make the experiment himself without much trouble or outlay. He needs merely to take a few tall, slender casks and to wrap them round with a well insulated copper wire, in such a manner that between every two turns there is left a free interval of 2 to 3 centimetres in width. A constant current is then passed through the wire for the requisite time, either from

a secondary battery or from a dynamo. It is quite practicable to pass the current over from one cask to another, so that a single source of electricity will suffice for a number of casks."

If the reputation of the author did not guarantee the uprightness of his intentions, we might be tempted to view this article as a companion piece to the former farce of the electric sugar refinery. It is really inexplicable that chemical action can be produced by simply circulating a continuous current around a cask of wine! The writer, who is led to his project by the sincerest desire to relieve the wine industry of Hungary, hard pressed by the phylloxera has either not carefully read the descriptions of his authorities or has misunderstood them. In relating how the electric current is passed from cask to cask, forming, in a manner, central stations for refining wines, he forgets to say whether the casks are to be arranged in series or parallel. For persons who might be induced to try the experiment recommended in a paper of such eminence, it is fortunate that the electricity will in this manner have as little effect as the high tension currents have upon the phylloxera. I speak here merely of the experiments for the electric execution of this criminal which have been actually carried out, but have proved total failures. In like manner, the experiments in the *Pester Lloyd*, if useless, will do no harm.

ELECTRICITY AT THE AMERICAN  
ASSOCIATION.\*

By Prof. H. S. CARHART.

THE address of Prof. Cleveland Abbe, vice-president of the Physics section of the American Association for the Advancement of Science, at the recent Indianapolis meeting, was on Terrestrial Physics. It touched upon the obscure question of the origin of terrestrial magnetism. Prof. Abbe concludes from the low permeability of iron at high temperatures that the metallic portions of the earth interior cannot be magnetised, and that terrestrial magnetisation must be restricted to the earth's shell or crust. He therefore inclines to the theory of magnetism derived from terrestrial currents in planes at right angles to the axis of rotation. He reasons that the earth is immersed in a dielectric, and is placed in some kind of electrical field due to solar radiation. If this were the case it would require no inconsiderable currents round the globe as a solenoid to produce the known terrestrial magnetism, since the cause operating to prevent permanent magnetism in the earth's interior would also prevent such material from serving as the core of an electro-magnet.

In the physical section Prof. Mendenhall presented facts, derived from the magnetic observations of the Coast and Geodetic Survey, going to show that magnetographs often record earthquake disturbances, not as mechanical shocks, but as magnetic perturbations. These he conceives to be due to the sudden stresses to which the earth is subjected in earthquakes; and these stresses modify the earth's magnetism. In support of this view he showed, from an analysis of the photographic records of magnetographs, that two diurnal fluctuations in declination depend upon lunar action; and he ascribes these to the stresses in the earth's crust produced by the same forces which raise the tides. The subject will be pursued further by observers of the Geodetic Survey.

Prof. Nipher, of St. Louis, described a new method of measuring the electrical resistance of liquids, such as the internal resistance of a battery. It consists briefly in placing the resistance to be measured in one arm of a bridge with a two-part commutator to effect rapid reversals of the current through the electrolyte. From measurements thus far made the results are found to agree with those of approved methods to within 1 per cent.

Mr. E. G. Merritt described the peculiar behaviour of a galvanometer when used with a thermopile. It consists in small periodic pauses in the deflection of the needle when the thermopile is exposed to a steady source of heat radiation.

These pauses, which may even amount to reversals in the motion of the needle, for a short distance, are always equi-distant in time; and the first maximum bears a definite ratio to the total deflection which the needle will reach if the radiation upon the face of the pile be continued indefinitely. Comparisons of different sources of radiant heat may, therefore, be made by observations of the first maxima occurring at the first pauses of the needle. The phenomenon was shown to be due to the composition of a damped vibration of the needle, and a deflection produced by an E.M.F., the law of variation of which may be expressed by an exponential curve. The paper was an admirable example of a short investigation completely worked out.

\* Electrical Engineer, of New York.

Sections A, B, C, and D of the Association spent one day by invitation at Terre Haute, and held sessions in the Rose Polytechnic Institute. An elegant dinner was served at the Terre Haute House to the 200 guests, and Colonel R. W. Thompson, ex-Secretary of the Navy, made the address of welcome. Colonel Thompson welcomed the Association to the same place 19 years ago. He excited lively interest by his vivid narrative of experience with Morse, and of his efforts to secure a \$25,000 appropriation from Congress to construct an experimental telegraph line. In this connection he said that one of his colleagues was subsequently defeated for Congress because his constituents disapproved of his vote for the appropriation for the telegraph. What a commentary on the righteous judgment of the people!

Many members took occasion during the meeting to ride on the electric railway in Indianapolis. It works admirably; and the central line of iron poles, carrying the wires, is an ornament to the street rather than a disfigurement. A large party accepted the kind invitation of the Parry Manufacturing Company to visit their factory for the purpose of witnessing electric welding on a commercial scale. They saw a single workman welding wagon tires at the rate of about three per minute. Two men were engaged in welding inch axles also, and both operations were conducted with the most gratifying success. The process is very satisfactory to the manufacturers, and its rapid introduction into large plants is assured.

The papers presented to the physics sections of the Association included a relatively smaller number on electrical topics this year than for several meetings. Other departments of physics received a larger share of attention than usual. The papers were of a high average, but none reached the highest water mark.

## ELECTRICAL CENSUS TAKING.

THE chiefs of the Population Division of the United States Census Office celebrated the completion of the count of the population of the United States by a dinner at "Glen Echo" recently. The "Hollerith electric tabulating system" has been in use by the Census Office for the tabulation of the schedules of the population taken under the eleventh census. Superintendent Porter in expressing his congratulations upon the rapid and accurate completion of this great work, spoke as follows:—

It may not have occurred to any of this little band of faithful workers, consisting of chiefs and section chiefs from the Population Division of the Census, that you are celebrating a great event here in this picturesque spot. For the first time in the history of the world the count of the population of a great nation has been made by the aid of electricity. The number of names on every one of 15,000,000 schedules has been registered twice by the nimble and expert fingers of the counters, and the 64,000,000 people have marched, as it were, under the vision of the young men and women who have done such remarkable work with such extraordinary rapidity and precision. What a procession you have had pass before you. The men who wrote those names have had to find them in every human habitation, and existing under every imaginable condition within this vast domain of ours. In June these blanks were distributed throughout the country. In July and August they find themselves back in the Census Office, counted twice and ready for the next statistical treatment. Allowing for the time spent in teaching and in fitting up the machines, the count proper was not commenced before July 1st, and the night force was not organised until some time afterwards. We have actually counted 128,090,000 in six weeks, or the entire population of 64,000,000 twice in that period. Beginning with 2,000 and 3,000 families, or 10,000 and 15,000 persons per day, the operatives progressed in dexterity, until last Thursday no less than 43 counted over 10,000 families or 50,000 persons each, one young lady reaching the astonishing total of 16,071 families or about 80,000 persons. On that day not only the highest averages were reached, but the greatest number counted, the report showing 1,342,318 families or 6,711,590 persons. This represents an average of 8,135 families or 40,675 persons per clerk. In this connection I think it my duty to say that in the "general average" the male clerks, man like, I hear some of the young women whisper, seek refuge behind the petticoats of the gentler sex. The average number counted by the women clerks was 9,590 families, or 47,950 persons, and by men clerks, 6,587 families or 32,935 persons. Thus it will be seen that the women average nearly one-half more than the men. It is also worth noting that of the 43 who counted more than 10,000, 38 were women and only five men. These facts, and indeed the record of the entire six weeks, show that women are better adapted for this particular work than men. They are more exact in touch, more expeditious in handling the schedules, more at home in adjusting the delicate mechanism of the machine, and apparently more ambitious to make a good record.

While I congratulate you on the completion of the rough count, and thank you sincerely for the great interest you have taken in this work, for the many extra hours you have freely given to keep it moving, I must sympathise with you in the sorrowful fact that you have no more countries to count. Alexander is said to have wept because he had no more worlds to conquer, and Hunt and Sutherland in the midst of this gay festivity look solemn and sad at the paltry total of 128,000,000, and, with a ghastly smile, I can

hear them say: "We had to count the population twice in order to reach those figures." Distance is overcome and lessened when we can flash our thoughts thousands of miles in a few minutes, and cross the Atlantic in five days. So it is in census work. With the force that left work this afternoon, working night and day as we have worked, we could, with these electrical machines, count the entire population of the United States in ten days of seven working hours each.

Estimating the population of the civilised world at 650,000,000, we could count it in 100 days; while the bright young women and sturdy young men of our population division could run through the entire population of the earth, which, including Asiatics and savages, is estimated at 1,300,000,000, in less than 200 days, providing places could be found to store the schedules. And while we thus glorify our own little achievement, we must not forget that we have here with us the modest man who invented the wonderful machine with which we have accomplished such magical results.

## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—LEEDS, 1890.

### RECENT DETERMINATIONS OF THE ABSOLUTE RESISTANCE OF MERCURY.

By R. T. GLAZE BROOK, F.R.S.

(Printed from Notes used for the discussion on Electrical Units in Section A of the British Association, Leeds, September 10th, 1890.)

WE are here to-day to discuss some of the determinations of the value of the ohm when expressed as the resistance of a column of mercury, with a view to seeing if any action is practicable by which the standards in general use may be brought nearer to their theoretical value than they are at present. The time is opportune, for we have the advantage of having in Leeds Prof. Mascart, of Paris, and Prof. Rowland, of Baltimore, under whose directions some of the most important of the investigations we are to consider to-day have been made, and Prof. Barker, one of the American representatives at the Paris Congress. Moreover, it seems probable that a Congress will again meet shortly to consider this question, and a preliminary discussion here may be of value in clearing the ground.

The question at issue is whether the results of experiment are sufficiently in accord with each other to render it probable that any number adopted by us would be generally accepted, and, if so, to determine what that number is.

The problem has two sides. The resistance of a wire is expressed by means of one series of experiments in terms of a length and a time, while by another series of experiments it is expressed in terms of the resistance of mercury, and thus the resistance of mercury is found absolutely. Frequently, however, there is an intermediate step; the resistance of the wire is expressed in terms of some standard resistance, and this standard is expressed in terms of mercury.

The methods employed to compare a standard resistance with that of mercury are all very similar in their nature, and the experiment is not one of very great difficulty. Accordingly we find that the results of the experiments are fairly concordant.

In Table I, column 5 gives the values found in B.A. units for the resistance of a column of mercury 1 metre long, 1 square mm. in section at 0° C.—a Siemens unit, as it is called. The values found by Lord Rayleigh and M. Mascart are higher than later ones. A comparison of the values found for the B.A.U. in ohms and for the Siemens unit in B.A.U. by M. Mascart, leads to the conclusion that possibly his B.A.U. had changed a little between the time at which it was compared with the standards at Cambridge and the time at which it was used. As to Lord Rayleigh's value, the fact that the coil *R* was his principal standard, and the coil *r* has certainly changed relatively to the other coils in the last two years, may help to explain the difficulty, but it must be remembered that *R* had the same value relatively to the others in 1888 as it had in 1881, when examined by Dr. Fleming.

The other numbers are in close accord, except one result of Salvioni's, which must, I think, be capable of a simple explanation. Strecker, Kohlrausch, and Salvioni differ somewhat from Wilkes and myself; in consequence, I believe, of the fact that they worked at the temperature of the room, while Wilkes and I worked at the temperature of melting ice. A small change in the temperature coefficient used by them would easily account for the difference.

Wuilleumeier's mercury coils were the same as those employed by Mascart, Benoit, and de Nerville. We may thus take '9535 B.A.U. as being very accurately the resistance of a column of mercury 100 cm. long 1 square mm. in section.

But when we inquire what are the results which have been obtained for the value, in ohms, of the B.A.U., or of the mercury unit, the discrepancies are considerable.

Let us consider the methods. An admirable summary of these will be found in Wiedemann's *Electricität*, vol. iv., p. 910, or in Mascart and Joubert's *Leçons sur l'Électricité*, ii., pp. 581, *et seq.* They have also been critically discussed by Wiedemann and by Lord Rayleigh in the *Phil. Mag.*, vol. xiv., 1882. We will take them in order,

VALUE OF OHM EXPRESSED AS THE RESISTANCE OF A COLUMN OF MERCURY.

	Observer.	Date.	Method.	Value of B.A.U. in ohms.	Value of 100 centimetres of mercury in B.A.U.	Value of ohm in centimetres of mercury.
1	Lord Rayleigh .....	1882	Rotating Coil.....	98651	95412	106.24
2	Lord Rayleigh .....	1883	Lorenz method .....	98677	—	106.21
3	G. Wiedemann .....	1884	Rotation through 180deg.....	—	—	106.19
4	Mascart .....	1884	Induced current.....	98611	95374	106.33
5	Rowland .....	1887	Mean of several methods.....	98644	95349	106.32
6	Kohlrausch .....	1887	Damping of magnets .....	98660	95338	106.32
7	Glazebrook .....	1882 and 88	Induced Currents .....	98665	95352	106.29
8	Wuilleumeier .....	1890	.....	98686	95355	106.27
	Mean.....			98656	—	—
9	Strecker .....	1885	An absolute determination of resistance was not made. The value 98656 has been used.....	.....	95334	106.32
10	Hutchinson .....	1888			95352	106.30
11	Salvioni .....	1890			95332 or	106.33
12	.....				95404	
	Mean without 12 .....				95355	106.28

	Observer.	Date.	Method.	Value of B.A.U. in ohms.	Value of 100 centimetres of mercury in B.A.U.	Value of ohm in centimetres of mercury.
13	H. F. Weber .....	1884	Induced current .....	Absolute measurements compared with German silver wire coils issued by Siemens or Strecker		105.37
14	H. F. Weber .....	—	Rotating coil .....			106.16
15	Roiti .....	1884	Mean effect of induced currnt.			105.89
16	Himstedt.....	1885	.....			105.98
17	Dorn.....	1889	Damping of a magnet .....			106.24
18	Wild.....	1883	.....			106.03
19	Lorenz.....	1885	Lorenz method .....			105.93

I.—Kirchoff's Method.

This has been used by H. F. Weber, Rowland, Mascart, and Glazebrook. The formula may be written—

$$R = \frac{4 \pi M}{T} \cdot h \cdot \frac{\alpha}{\beta}$$

Where M is the coefficient of induction between the coils, T the time of swing of the galvanometer needle,  $\alpha$  the deflection due to primary current,  $\beta$  the throw due to the induced current, and  $h$  a ratio either of two galvanometer constants or of two resistances; all small corrections are omitted.

The main difficulty is in calculating the value of M, which depends approximately on  $a^2/b$  if  $a$  is the radius of either coil, and  $b$  the distance between the coils.

In the coils used by myself the value of  $a$  was about 26 cm.; that of  $b$  varied from 12 to 24 cm. An error of 1 mm. in  $b$  produces an error in the result between 1 in 1,500 and 1 in 2,000. In one position of the coils, the correction arising from the fact that the cross-section of the channel was of finite area was less than 1 in 1,000. There should, it seems to me, be no difficulty in finding M to the one or two in 10,000. The coils used by Rowland and Weber in their earlier experiments, and by Mascart, were smaller. In his last experiment in 1883 Weber used coils of 32 cm. radius. In their later experiments Rowland and Kimball had large coils, about 50 cm. in radius.

The various results are :

H. F. Weber .....	105.37
Rowland .....	106.29
Mascart .....	106.33
Glazebrook .....	106.29

It will be noticed that all H. F. Weber's results are very low. He used as his standard wire a 10-Siemens unit taken from a resistance-box, not a coil which had been compared directly with mercury, and it seems possible that a common error in this affects all his results; he also used large magnets. The other values are in fair agreement, though we may probably agree with Lord Rayleigh in thinking that the limit of accuracy of the method has not been reached.

II.—Weber's Method.

The approximate formula again is

$$R = \frac{2 \pi G g}{T \beta} = \frac{4 \pi^3 N N'}{T \beta} \cdot \frac{a^2}{A}$$

where G is the constant of the galvanometer,  $g$  the area of the earth inductor, and in the second expression,  $a$  is the radius of the inductor, A, of the galvanometer, N and N' being the number of turns on either.

This method was followed by Mascart, who used with a coil of 15 cm. diameter and a galvanometer the constant for which was compared with one of known constant—viz., the inductor. The time taken to turn the inductor was one-fifth of the time of vibration of the galvanometer needle. There is the difficulty of making the axis vertical and the effect of the time of duration of the current on the throw of the galvanometer to consider. My experiments

show that if the effect of the induction current be prolonged for a period of one second, the time of swing being 23 seconds, then the deflections are reduced by 1 per cent. With the circuit open for two seconds the effects are marked.

The same method has been used by G. Wiedemann, who is inclined to think it the best. He employed coils of W. Weber and Zollner, one metre in diameter, which were wound and measured twice. He calculated G using as galvanometer coil a counter-part of the inductor; the effect of the current was determined by measuring effects of a series of impulses at proper moments. The time of turning the inductor was two seconds, while the period of the needle was one minute. This would tend to reduce  $\beta$ , this to increase R, and hence to decrease the length of the column, which was found by comparison with a Siemens unit; the same unit was compared with mercury.

Mascart thinks the difficulties of this method inspire with doubt the results thus obtained. Experiments near the magnetic equator would, Lord Rayleigh points out, decrease the effect of level error. Wiedemann thinks this method is to be recommended for final determinations. Rowland criticises the method.

The results obtained are :

Mascart .....	106.37
Wiedemann .....	106.19

III.—Method of British Association Committee.

$$R = \pi^2 N^2 a \cot. \phi$$

The only measurement, apart from corrections, is that of mean radius. The corrections, however, are important, for the self-induction of the rotating coil requires to be known, while the magnetic field in which the coil is moving is modified by the presence of the magnet at its centre, so that the magnetic moment of this magnet has to be determined. In order to reduce the amount of this correction, this magnetic moment is made small, and this again leads to difficulties.

The following difficulties are urged by Wiedemann :

- (1) Correction due to self-induction. (2) Difficulty of levelling. (3) Want of steadiness from draughts, etc. (4) Small magnetic moment.

In reply, we may say that

- (1) Can be corrected for. (2) Level error common to several methods (see II. above). (3) Effect can be eliminated by experiments with open circuit. (4) Theory of the correction is very simple; a knowledge of M H only is required.

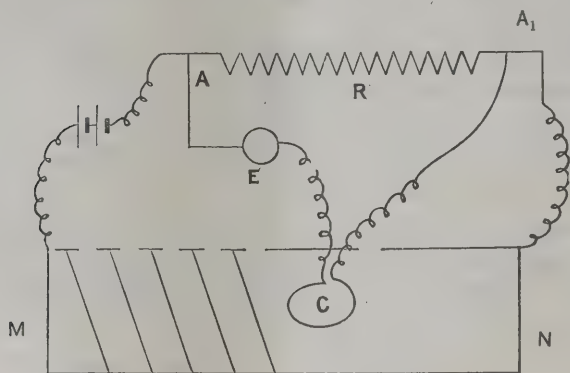
The method was used by Lord Rayleigh, leading to the result, 106.24. It was also employed by H. F. Weber, who used rotation about a horizontal diameter in the magnetic meridian to avoid the correction depending on M/H.

IV.—Foster and Lippmann.

$$R = 2 \pi^2 \frac{a^2}{A} \cot. \phi N N'$$

A rotating coil is used, but contact is made only at the moment when E.M.F. is a maximum, and E.M.F. is balanced by that due to an

external current through a known resistance. Observations have been recently carried out by Wuilleumeier by this method with modifications. He used the induction from a long spiral, MN (see figure), 2 metres long 30 cm. diameter, placed east and west, wound with one layer of wire 2 mm. in diameter. A coil, C, wound on a disc of hard wood, 20 cm. in diameter, rotates in this, and the circuit is closed when the E.M.F. in this a maximum; the E.M.F. thus produced is balanced against that produced in the current in the spiral when flowing through a resistance, R, the action of the earth's magnetism being compensated. One point, A, of R, is in connection with the coil through E, the other end is straight, and a movable contact is established at A<sub>1</sub>, A etc. Corrections for its ends are obtained by shifting the spiral coil. The resistance of R was about 3 ohm, made from a strip of German silver of rectangular section 34.72 metres long, 1 cm. broad, .3 cm. thick, immersed in naphtha.



The primary current was 12 amperes. A Lippmann electrometer was used. The E.M.F. was nearly four volts. The diameter of the rotating bobbin was 20 cm. Hence, error of .1 mm. in mean radius makes error of 1 in 1,000. The formula assumes spiral to be uniformly wound. Result is 106.267.

#### V. Method of damping.

Set a magnet in a coil. The motion of the magnet sets up currents, which react on the magnet and damp it. A relation can be found between these currents, and the rate of damping. To a first approximation it is

$$R = \frac{\pi}{2} \frac{1}{T} G^2 \frac{M}{H} \frac{(\pi^2 + \lambda^2)}{\lambda - \lambda_0}$$

$\lambda, \lambda_0$  being logarithmic decrements.

G has to be compared with the constant of another coil, because of the size of the coil. Let  $h$  be the ratio—

$$R = \frac{2\pi^2}{T} \frac{N^2 h^2}{A^2} \frac{\pi^2 + \lambda^2}{\lambda - \lambda_0} r^3 \tan \alpha.$$

Where A is the radius of standard coil, N the number of its turns,  $\alpha$  the deflection which the magnet produces in Gauss's first position when at a distance,  $r$ .

Further corrections are required for length of magnet, and for the uncertainty as to the distribution of its magnetism and for self-induction.

In the opinion of Lord Rayleigh and Rowland, the final formula is enough to show that the method cannot compete with the others. Other difficulties are that calculation assumes the arc of oscillation is small, G is not independent of the displacement.

Currents are set up in the magnet, which affect its motion. A correction is required for temporary induced magnetisation due to action of current, this may be appreciable. In general there are difficulties in applying the theory.

The method was used by H. F. Weber. His magnet was 8 cm. long, his coil 16 cm. in radius; G was calculated, a uniform distribution of magnetism being assumed.

Dorn introduced corrections to the theory; he found G by comparison with a large coil, compared result with a Siemens unit, verified by Strecker; his magnet was 17 cm. long, closely surrounded by the coil. Wild suspended the magnet bifilarly; it was 29 cm. long, and the coil closely surrounded it; a resistance-box was used.

Kohlrausch's magnet was 20 cm. long, with brass ends. The coil was close to it, G was compared with that of a large galvanometer. Resistance compared directly with a tube calibrated by Strecker.

The results are:

H. F. Weber .....	104.77
Dorn .....	106.24
Wild .....	106.03
Kohlrausch .....	106.32

#### VI.—Lorenz Method.

$$R = n M.$$

The main difficulty lies in the calculation of M. This is more easy than in I, for the disc can readily be measured.

In Lord Rayleigh's apparatus an error in the radius of the coil does not greatly affect result. Further increase of size possible and desirable. The smallness of the effect, and therefore of R is not fatal. See Lord Rayleigh's observations.

Thermo-electric effects can be compensated for.

Results:

Rayleigh .....	106.24
Rowland .....	106.29
Lorenz .....	106.19

Lorenz value is too low because of the size, of the mercury tubes used by him.

#### VII.—Roiti and Himstedt.

$$R = n M \frac{a}{\beta} = n 4 \pi^2 a^2 \frac{N N_1}{1} \frac{a}{\beta}.$$

There is a difficulty in having many contacts, for if the contact does not last all the time supposed,  $\beta$  would be too small, R too large, and the length of column too short. There is also an important correction for the ends, and the assumption is made that the coils are uniformly wound. Another difficulty is the theory of the galvanometer under such discharges.

The resistances were compared with a Siemens unit, and in the case of Roiti with one of Strecker's coils.

The results are:

Roiti .....	105.89
Himstedt .....	105.98

#### VIII.—Calometric Methods.

The results by these methods cannot claim any great accuracy.

Having thus completed the review of the methods, we must look at the results; and after what I have said, we may, I think, reject all work previous to 1882.

The results of H. F. Weber are manifestly too low, while serious doubts attach to the methods of Roiti and Himstedt. For Weber's first method, the early results of W. Weber and Zollner may be omitted compared with those of G. Wiedemann, while the results given by the method of damping will be sufficiently represented by the work of F. Kohlrausch, who alone of those who used this method compared his results with the resistance of mercury directly.

The experiments of Lorenz will not, I think, stand rigid criticism, while, unless I am much mistaken, Lenz, who also used Lorenz' method, has only published results and not details.

We are thus left with the following list, including the results only of those who have made both the mercury and the absolute determinations:—

Lord Rayleigh .....	106.23
Mascart .....	106.33
G. Wiedemann .....	106.19
Rowland .....	106.32
Kohlrausch .....	106.32
Glazebrook .....	106.29
Wuilleumeier .....	106.27

Mean ..... 106.28

If we take in Lord Rayleigh's results for the value of the B.A.U. in ohms, for 100 cm. of mercury in B.A.U. the value .9535 instead of .9541 given by his own experiments, we get, instead of the values 106.21 and 106.24 the values 106.27 and 106.30. The mean, then, of the whole would be 106.29. If we include the three numbers (9, 10, 11) of the table, we get the value 106.30.

It seems, then, to me, that the number 106.30 certainly expresses the true value within one or two in 10,000, and that the time has come for carrying the conclusions of the Paris Congress one place further.

The establishment of the new standardising laboratory calls for some authoritative expression of opinion here in England. Are we prepared to express our opinion?

In 1886, the Standards Committee agreed, on the motion of Sir W. Thomson, (1) to recommend for adoption for a term of ten years the legal ohm of the Paris Congress as a legalised standard sufficiently near to the absolute ohm for commercial purposes, and (2) that at the end of ten years, the legal ohm should be defined to a closer approximation to the absolute ohm.

The Government took no action on this matter, and the opportunity is afforded us of revising, not in ten years, but in four, our provisional suggestion. Shall we replace the 106 cm. by 106.30 cm.

For my part I should be guided greatly by the amount of acceptance that such a decision would meet with. If Prof. Rowland and Prof. Barker, who was with us in 1886, can tell us that they would agree in recommending the Government of the United States to adopt the same view, and if Prof. Mascart thinks that such a course would meet with the approval of himself and his distinguished colleagues in France, I should be heartily glad of it.

If, on the other hand, they press for further time in order that experiments of a higher degree of accuracy, which can no doubt be attained, though probably at great cost, may be carried out, I should deprecate the Committee coming to any conclusion which might pledge them to a number which does not meet with general acceptance.

#### DISCUSSION.

Prof. ROWLAND (America) said, as one of the members of the United States commission for the determination of the ohm, the matter in America was entrusted to me. The commission consisted of Profs. Barker, Trowbridge, and myself. The experiments were carried on at the John Hopkins University, under my superintendence, with considerable appropriation from the United States Government. The experiments have been going on for many years, and we have continued to experiment down to the present time, and, indeed, the whole matter has been gone over by one of my associates, Dr. Duncan, Professor of Applied Electricity

and he, with his students, has determined not only the absolute unit, but also has made a complete determination of the mercury unit. Unfortunately, I cannot bring figures, as I have been travelling for several months, but they have been gone into, as I said, very carefully, and, if I recollect rightly, the number, 106.32, has been slightly diminished. Mr. Glazebrook's criticism, however, has been so exhaustive that I can add very little with respect to it. As to which are the best methods, there are very few who will dispute that the method of Lorenz is the best for this determination. You have a very definite quantity to measure—the diameter of a revolving disc, which is a very definite quantity—and then, as Lord Rayleigh has shown, the determination can be made, so as to almost entirely eliminate the radius effects of the coil, that is the most important feature of the experiment, because nothing is undetermined in the experiment, such as the radius of the coil of wire. You wind the coil in the groove, but as to where the different wires are in the groove it is impossible to determine with any very great accuracy; so, if we can eliminate this quantity, we can get more accurate results. Therefore, all experiments which depend on the square of this quantity, as, for instance, when you have revolving coil, I think all have this source of error. I think the Commission of the United States would be perfectly willing to recommend the figures, so far determined. Those who were connected with the commission will recollect that the United States never recommended to the Government any figures whatever. The 106 decided on by the Paris Conference was never accepted by the United States, even provisionally, and therefore the matter has been left entirely open to the present time, because we felt that you in England would come to some figures of this sort. We are now prepared in America to recommend some figure based on the result here given, and I may mention that the Superintendent of the Coast Survey has intimated to the committee that they are willing to establish a bureau of electrical measurement, under the charge of the United States Coast Survey. I do not suppose they will take up many units, but at least they will take up the unit of resistance, if they have the sanction of the United States Government.

LORD RAYLEIGH said that it made him feel very antiquated to see his name at the head of the list of 18 determinations of the ohm. He thought Mr. Glazebrook was quite right to begin where he did, because before 1882 the results obtained were comparatively wide. At that time discrepancies of 3 per cent. existed. It was very satisfactory to find that now the whole question was narrowed to one in a thousand instead of three in a hundred. Certainly, looking at those figures, and listening to Mr. Glazebrook's able exposition of the methods followed by various observers, it looked very much as if the number obtained by himself for the specific resistance of mercury were a little in error. That number, .9541, was higher than those found by recent experiments. The only difficulty he found in accepting that view was that he found the observation exceedingly easy to make, and probably, for that reason, he was wrong. But still, he was not content with an agreement between the first two or three measurements. The experiments were protracted for a considerable time, and considerable variation was used in preparing tubes, and the degrees of concordance in the results was very great. Certainly, at the time, he would have thought it extremely unlikely that any repetition could have altered the figures .9541 into .9535, or whatever was thought most probable. At the same time, anybody who had had any experience of that kind of work must know that unexpected errors did creep in. Since the publication of Mr. Glazebrook's paper upon the subject, in which to a great extent the same method, and even the same apparatus, was used as that which he (Lord Rayleigh) employed, he had gone into the matter very carefully, in the hope of, perhaps, finding where the difference lay between them. But he had been unable to find any error in the work which led him to the higher number. The notes of the experiments were nearly complete; and it was as easy to make the calculations now as at the time of the experiments. He could not explain the discrepancy, unless there had been a shifting in the standard coils themselves, in comparison with which the mercury tubes were observed. Mr. Glazebrook had shown that if they discarded that number (.9541) and substituted for it the recent comparisons of mercury with the B.A. unit, then the absolute numbers that he (Lord Rayleigh) obtained for one B.A. unit would lead to very nearly the same results for the length of the mercury column as had been obtained by others. It looked as if the general balance of evidence was in favour of 106.30, which Mr. Glazebrook had taken, although he might be sanguine in supposing that we are confident of it to two parts in 10,000. He was in commenting upon Lorenz's work, to say that he had not taken not quite sure whether he had rightly understood Mr. Glazebrook, account of the manner in which a current would enter a wide column of mercury from a wire. It was a good many years since he had taken this into account. He had a distinct impression of functions which would represent the manner of divergence. At any rate, he must have been quite on his guard in that matter. He (Lord Rayleigh) was sometimes inclined to think that a little too much importance was attached to the expression of the resistance of mercury absolutely. Supposing that they could be quite sure the length of the column of mercury was 106.30, what use were they to make of the fact? An electrician, in his laboratory, did not find it easy to set up a mercury tube, and to obtain results by that method. In a factory, it would be still more unlikely that mercury would be employed for the purpose. Practically, to make use of the determination, they must have a wire. He was inclined to think the numbers expressing the B.A. unit were quite

as important as those into which mercury entered. Mr. Glazebrook had explained that a wire was first expressed in absolute measure, and then the comparison was made with mercury. It was very important, no doubt, to make that comparison for standard wires, but it was really the wire that was wanted for practical purposes, and therefore he thought as much importance should be attached to the fifth column of figures as to the last. The only other thing that occurred to him to say was that he did not quite understand why so very much less importance is attached to the determination of the ampère as to the determination of the ohm. They had there a long series of determinations on the subject of the ohm. So far as he knew the received ampère depended upon only two sets of observations, those of Prof. Kohlrausch and himself. It was true that it was more difficult to define the ampère than the ohm, but it was as important that it should be defined; and he would suggest to those who still felt inclined to experiment on the subject of electrical units, to repeat the measurement of the ampère, feeling that that is perhaps liable to greater uncertainty than attached to the ohm.

Prof. BARKER (America), expressed great gratification at the reception they had met with. He had been struck with the clearness and justness of the statements of Mr. Glazebrook in regard to the matter. It had been placed before them in such a manner that the thanks of the section were due to him. He felt that they in America occupied an anomalous position in regard to the ohm. When the Congress of 1881 determined to submit to experimental determination in the various countries, the work was undertaken on behalf of the United States by their committee under the presidency of Prof. Rowland. The work occupied some time, and was made with a great deal of care, in consequence it was not completed when the meeting of 1884 took place. They (the committee) petitioned for a further postponement, in order to enable the results of the American experiments to be presented at the Paris Congress. This, however, was not done. As they all knew, action was taken in Paris upon results which did not include the American observations. Having no part in it, therefore, they should be considered to be entirely independent as to whether 106, which is dignified by the name of the legal ohm, although it has never been legalised in England or America, should be still further legalised by England or the United States, or whether what seemed positive knowledge now should not be legalised. As Mr. Glazebrook said, it was fortunate that the English Government took no action in regard to the matter. He (the speaker) attended the meetings of the committee, and he supposed the pressure of having some legalised standard led to the suggestion of Sir William Thomson that 106 should be adopted. At that time probably that figure came up to their knowledge, but now was an opportune time to take legal action. He seconded Prof. Rowland's opinion that the United States would be very glad to adopt 106.3, which the committee of the B.A. recommended for adoption as the ohm. It would be also great satisfaction if Prof. Mascart would secure similar simultaneous action in France in the same direction. They in America were very much indebted to Englishmen for the work accomplished here, more especially to the various committees of the B.A. He might be allowed to refer to another matter, scarcely germane to the subject under discussion. It would be remembered that at the Paris Exhibition of 1881 the name of Weber was taken away from unit of current, and the name of Ampère substituted, and the name of Coulomb for quantity. At that time, he (the speaker) suggested that the Americans were entitled to some sort of representation, and he suggested the name of Franklin for one of the units, which was seconded by Prof. Mascart. This, however, was not done, and he wished to say that they would support England in the matter of the units, if it would support them in getting in the name of Franklin somewhere.

SIR WILLIAM THOMSON said he was afraid he might be held to be a partisan of 106. He begged to say that he was not, and never was. He thought Mr. Preece would bear him out in that. They fought hard for 106.25 at the Paris Congress, but the case turned out for 106 or nothing; and for the whole German scientists and instrument makers to be left to the Siemens unit. The two brothers Siemens, Werner and William, were present, and they very much desired that a mercury unit should be kept, recommending and suggesting very good reasons for keeping it, reasons to which Lord Rayleigh alluded, and which they still considered of great importance. The mercury unit then was adopted, and the question was how many centimetres, instead of the Siemens 100, was to be taken for the new unit. Now, it so happened that there were no observers present (and there were a considerable number of distinguished men present from Germany and Italy), but no observers whose results went above 106; the average of all the results before the Congress came to almost exactly 106. He urged that Lord Rayleigh's were worth all the others put together, and he believed that he persuaded the mass of the Congress to that fact, but he could not bring them to the point of voting. When four years ago he proposed the ten years period, and that was carried by the B.A., electricians did not live so fast as they did now, and he was only too glad to see that four years had done the work of ten, and he cordially agreed with Mr. Glazebrook, Prof. Barker, and Prof. Rowland in feeling very thankful indeed that the British Government did not take any action on the resolution of the B.A. committee adopted four years ago. He cordially agreed in the idea held now by persons present and many who were absent that now had come the time for fixing the standard at 106.3. He thought that nearer than 106.4. The results were certainly much more than 106.2, and less than 106.4. 106.3 was the nearest whole

number, it was much better than 106. It was within 1 or 2 parts in 10,000 of the true value. One word about the B.A. method. He did not know that there would be any proposal to go on with any more elaborate methods, but if any more great experiments were to be made, he would just say a word for the B.A. method that they had not yet seen all that it could do. He spoke of that very question with Clerk-Maxwell, about levelling and sensibility, and it was obvious that the right place to do the experiment was the equator, and Clerk-Maxwell was ready to go there to do it; and he (Sir William Thomson) believed that if he had been spared he would have kept that in view. Going to the equator would at once increase the sensibility in the ratio of the horizontal force at the equator to the horizontal force in England. It would absolutely do away with all trouble in respect of level. He hoped, if any more observations were made, the B.A. method would be kept in view with that fact, that results at the equator would be more accurate than it was possible to get with observations made in Leeds or at Cambridge, where they had been made. He called attention to the remarkable agreement now between the results of several observations obtained with such very different methods. It was quite surprising to find all come so close to that 106.3, when they considered the great difference between the methods.

Mr. PREECE said he thought to a certain extent he must accept the responsibility of having advised Her Majesty's Government to decline to accept the 106 as the legal unit in 1886, and the reasons for that course were very powerful and very numerous. Any change that would have then been made would have meant most serious expenditure. The number of apparatus adjusted to the B.A. unit, not only in this country but in the colonies and all over the world, was so enormous that any change made would have been a matter involving one costing many thousand pounds, and one that would certainly result in another change within ten years. There is no doubt it would have been wrong then; on the other hand, there is equally no doubt that at the present time we shall be perfectly right in making a change. After hearing what has been said on the subject, he would not have the slightest hesitation in recommending 106.3 to the Institution with which he was connected as representing the true ohm. They must remember that although it might not be absolutely accurate, it was as accurate as most measuring instruments, in some cases far superior. In reply to Lord Rayleigh's question why we did not measure the ampère, the measurement depended not only on the accuracy of the ohm, but also on an accurate knowledge of the measurement of the volt, and when they had the volt represented as accurately as the ohm, then, perhaps, they might fall back upon the ampère. At the moment, the only measurement of the unit, E.M.F., was the measurement made by Lord Rayleigh himself, and he did not think that as accurate as the mean results brought before them that day. Although the discussion before them took in view general electrical units, he did not wish to raise any question except on that of the ohm, still he wanted gentlemen present and electricians to take into consideration at some future day the entire alteration of the volt. It was a most unfortunate thing that the volt was taken as equivalent to  $10^8$  C.G.S. units. It had been done so because the particular volt and the E.M.F. of the Daniell cell were very closely allied. But if the volt had been made  $10^9$  instead of  $10^8$ , then their practical unit of current the ampère, would have been exactly the same as the unit C.G.S. that is now nearly always used in enquiries, so he felt quite sure that the day was not far distant when all electricians would have to take into consideration the enlargement of the volt, and it would be beneficial in enlarging the other units at the same time. To take an instance, there was the watt, this was too small to use; as the unit of the power they had to call it the kilowatt, and because it was called that it did not go down so smartly as if it had been called the watt. If they raised the volt to  $10^9$  they would also raise the watt, then the watt would become very nearly a man power and  $\frac{1}{2}$  of horse power, and they would obtain a unit of power scientifically accurate, and so closely allied to existing units used by engineers in general that the ridiculous horsepower would be driven out of existence, and the watt used instead. With regard to Professor Barker's suggestion as to the name of Franklin, they all agreed that if it was possible to slip in the name they would, but it was not the only name they wanted to slip in, there was Henry which had been suggested in America as the unit of self-induction, he could promise Mr. Barker that if any new nomenclature was wanted the names of Franklin and Henry should receive consideration.

The following discussion took place on Messrs. Lawrence and Harries's paper "On Alternating Currents in relation to the Human Body," and Mr. Wilson Hartnell's paper on "Fire Insurance Rules," published last week.

Mr. PREECE said the two papers read touched upon a question which was at the present time of great importance, that is, the danger to person. The way in which Messrs. Lawrence and Harries had worked at the question from a personal point of view was a right one. They had attacked the question in a scientific manner, very gradually accumulating well assorted facts, and very gradually giving them to understand how the human frame became influenced by the currents, and the result to a certain extent was startling; it was startling to find that alternating

currents were so much more painful than continuous currents, and also startling to find that these sensations of discomfort could be produced with such ridiculously little currents. Those who had spent their lives, as he had, in the practical applications of electricity, knew something about the effects of shocks. He supposed, in his career, he must have received a million shocks, or perhaps more; at any rate, when those two gentlemen read their paper before the Institution of Electrical Engineers, he was conscious of the fact that the severe shocks they had experienced were due to such ridiculously low currents. Small as the currents were, they possessed a danger; not that the currents themselves would hurt, but that the reception of a shock would frighten a timid person and probably cause him or her to fall down, and produce, as is often the case, a stoppage of the heart and death from other causes. The subject of the danger of currents was brought up last year at the meeting at Newcastle, and it led to considerable discussion. In the address, he ventured at that time to point out how extremely unscientific and inaccurate any attempt to introduce electricity for executionary purposes was until they knew about its influence, and the result had fully confirmed his doubts of the whole matter, and they had seen that they scarcely knew what they were going to do; and from the papers before them, they had a great deal more to learn before they dared to use electricity for the purpose of execution. There were many points he would commend to the notice of Messrs. Lawrence and Harries before they had thoroughly thrashed out the matter, one in particular was the effect of electrostatic charges on the human frame, and also the effect of self-induction of electro-magnetic apparatus, through the sudden rise and fall of the current. Continuous currents rose very gradually, and did not influence much the human frame, but if a current rose suddenly, they would be certain to get severe and serious shocks. Complimenting the readers on their paper, he did not think the effect of such papers would be to increase the timidity of the public in the use of electricity, because after they had shown the currents were dangerous, it was equally easy to see that they could be absolutely safe, and while an alternating current of 100 volts, with a frequency of 60 or 70, might hurt them very much, there was no reason why they should receive a shock. The dangers could be made simply innocuous by placing the wires out of reach. He could scarcely agree with the views put forward by Mr. Hartnell in regard to the fire office. The rules were made for their own guidance, and not for the benefit of electrical engineers and contractors. He considered Mr. Hartnell had referred sufficiently to the question of bad joints, which was a frequent source of danger in houses in generating heat. Insurance offices, or the majority of them, had acted upon the rules of the Institution of Electrical Engineers, which were carefully drawn up. In conclusion, the speaker drew attention to accidents which might occur through leakage where moisture had fallen.

Sir FREDERICK BRAMWELL was not able to follow Mr. Hartnell in what he would call the basis of his paper. He understood it to deal with a certain size of wire as being competent to carry, and to continue to carry, for an indefinite time, and under all circumstances, a certain current of electricity without the danger of a certain temperature being attained. It seemed to him that the heat would be developed regularly during the interval of time, and the temperature would continue to increase until the dissipation of heat from the surface of the wire was carried off. It was doubtless wrong to give the size of wire to carry a certain heavy current without knowing the incidents of the surroundings of that wire. He would have liked to have taken one of Mr. Hartnell's wires and surrounded it with asbestos and then see what the result would have been. He thought the author of the paper omitted the very important consideration of the surroundings of the wire carrying the current, this should be taken into account. They could take a glow lamp and hold it in one's hand, but if they wrapped it in three or four thicknesses of handkerchief they would set it on fire. Therefore, in all these experiments the considering how far those who made the rules were reasonable in those rules, it was well to bear in mind the circumstances of the surroundings.

Major-General WEBBER referred to the rules drawn up by the committee of the institution, and said this was done to avoid any conflict. They laid down principles and left the bye-laws to be drawn up by the companies. He considered the prominence which had been given to the subject in the *Times* was to a certain extent detrimental to the industry. It made people imagine there was something very mysterious in the dangers likely to arise. Had the dangers of gas been placed before the public in the same way as the dangers of electric lighting, very little gas would have been in use. The rules in existence at the present time were amply sufficient for all purposes. He felt that the use of casing, except in certain cases, would gradually die out. The companies in insisting on casing between floors and ceilings were doing themselves considerable harm. The speaker then referred to the rules published in his British Association paper last year.

Mr. KAPP considered that although the current density rule was a very unscientific one, yet it worked very well in practice.

Dr. HARRIES, in reply to the criticisms passed upon his paper, said the resistance of the body depended on the contact and upon the state of moisture. Smaller currents unusually caused a great deal of pain, the larger one causing unconsciousness so quickly that no pain was felt. He did not propose to enter into the matter of execution, but they had a good deal to learn before they could safely say that a certain current would kill. The recent affair in America was, in his opinion, bungled in a fearful manner.

Mr. HARTNELL replied to remarks made upon his paper, but was indistinctly heard.

# TESTING IRON.

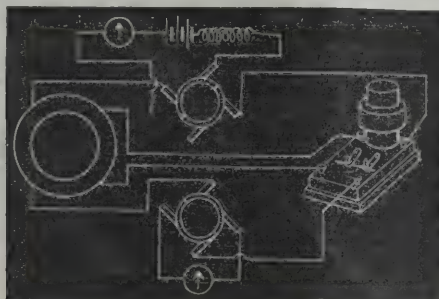
By J. SWINBURNE and W. F. BOURNE.

(Read before Section A, Leeds, September 9th, 1890.)

In practical work iron has to be tested as to its permeability and as to the loss by hysteresis. As regards permeability tests, the ordinary ballistic galvanometer method can, of course, be used; but a ballistic galvanometer is not a convenient instrument, and the method is too slow for practical use. It may, therefore, be of interest to describe the apparatus we use commercially. It is the development of a method devised in 1886. (See *Phil. Mag.*, July, 1887.)

The various samples of iron are obtained in the form of wire, and made up into rings, being wound on a former kept for the purpose, so that all the rings are alike as to dimensions. Before winding, the specific gravity of the iron is taken by weighing, and the specific resistance is measured. The ring is weighed to get the volume of iron, and is then wound with suitable primary and secondary wires.

The arrangement is shown diagrammatically in the annexed figure:—

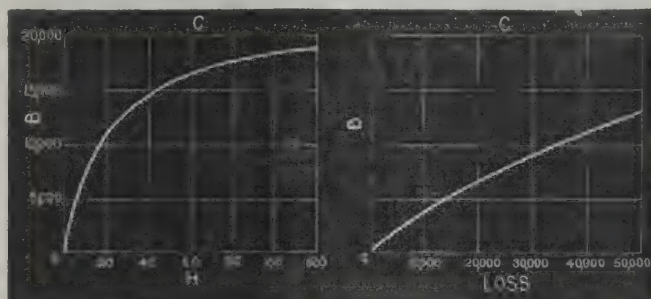


The circuit from secondary cells is led through an adjustable resistance, then through an ammeter to a commutator, resembling Brillouin's, which is driven by a belt from any shafting that may be near. The circuit is led through the primary to an induction box to the ring under test, and then back to the commutator. The circuit is then led back to the cells. The induction box consists of a primary coil, standing on end, and a number of secondary coils arranged so that the mutual induction is the same for all of

was taken, and put in the place of the sample ring, and its mutual induction measured with the induction box. To allow for the error due to the shortness of the cylinder of the standard coil, it was slipped out of the pilot coil, and moved exactly half its length in a direction along its axis, and a new reading taken. This reading gave the error due to the ends of the cylinder. A shunt was then put across the primary induction box, so as to make the readings come out in microhenrys.

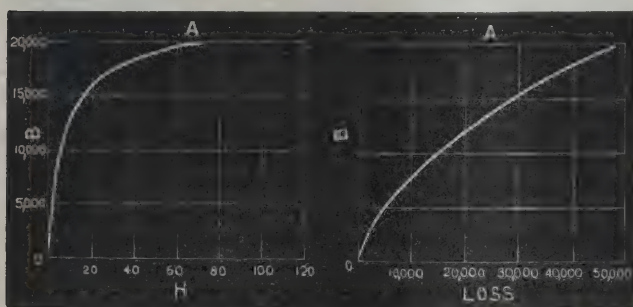
To test a sample of iron all that is necessary is to alter the mutual induction by steps, and to bring the galvanometer to zero for each step by means of the adjustable resistance. As the galvanometer is dead beat the readings can be taken in a few minutes.

The importance of loss by hysteresis in alternate current work is only now beginning to be fully realised. There are several ways of measuring the loss in transformers, but none of them seem satisfactory. Sometimes the transformer is put in a calorimeter, or else it is assumed that the pressure and even the exciting current vary harmonically, and have a so-called "angle of lag." The published efficiencies of most transformers are got by finding the loss from the copper resistances, and neglecting the loss in iron altogether. There is still another method, and that is taking the curves of pressure and current. Prof. Ryan has been singularly successful in this with a modification of Joubert's method.



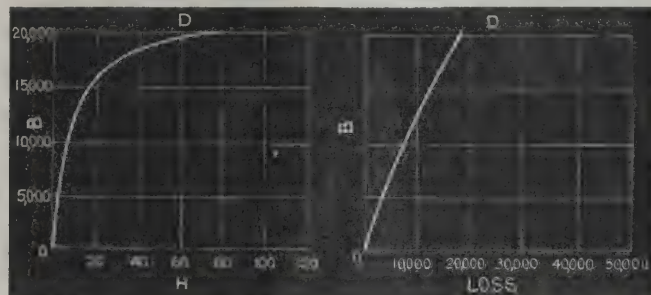
C.

Tests of transformers by means of lag angles and calorimeters have been published by Profs. Ferraris and Ayrton, and Major Cardew. As the loss in a transformer can be divided into the loss in the copper which varies as the square of the load, and the loss in the iron by hysteresis and Foucault currents which remains constant, these results can be checked. The results published,



A.

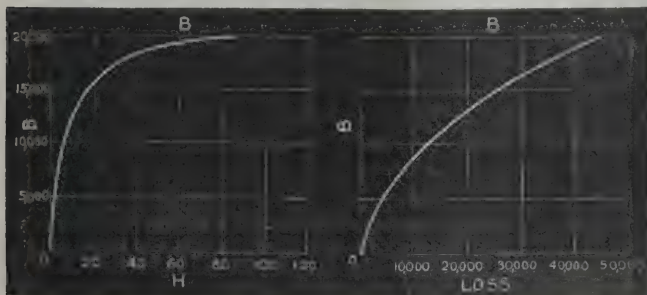
them. The secondary coils are led to buttons, and the switches include them by ones or tens, making the readings in steps of one per cent. of the highest. The primary of the sample ring is in series with that of the induction box. The secondaries are coupled so as to oppose each other, and arranged in circuit with a second commutator; a Varley, or, as it is more often called, a Deprez-d'Arsonval galvanometer, being inserted in the circuit. The two



D.

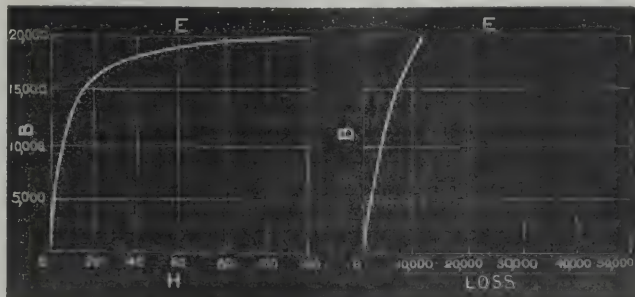
as obtained by these experimenters, show inaccuracies that make them quite valueless. The loss in the iron in Prof. Ayrton's experiments varies 160 per cent. of its smallest value, while Prof. Ferraris's cores give out power working as refrigerators. (See article "On Induction and other Things," *ELECTRICAL REVIEW*, October, 1887.)

There is really little reason for measuring the loss in a transformer; it is much simpler to measure the loss in the iron. No



B.

commutators are, of course, on the same spindle. The adjustment of the induction box was carried out as follows: The coils were roughly calculated to give a mutual induction a little in excess of a convenient round number per turn of secondary. A cylinder of a known diameter with a known number of turns per centimetre in the primary, and a known number of turns in the pilot coil



E.

one would think of measuring the loss in the copper by means of a calorimeter or angle of lag method. All that is needed is to measure the effective current and multiply its square by the resistance, the resistance being determined from the specific resistance of copper, or by direct measurement. Similarly, in the case of the iron, it is best to determine the qualities of the iron once for all,

and then the efficiencies of all transformers made of it can be foretold.

We use the same rings as for the permeability test, but do not employ the secondary wires. The loss of power at various frequencies and inductions is taken with a wattmeter. It is sometimes supposed that a wattmeter cannot be made with little enough self-induction to read accurately. If there is much self-induction in the pressure or shunt circuit, the reading will be lower than that with a direct current if there is no self-induction in the circuit in which the waste of power is to be measured; but if the current is behind the pressure, as in measuring the loss in iron, the wattmeter may even read too high. We therefore designed a special instrument, which was made for us by pupils of the London College of Electrical Engineers. The current coils are fixed, and the moving coil is suspended by a fine wire, with a fine spring at the foot, to take the electricity out again. The moving coil has few turns and little self-induction, and a large non-inductively wound resistance is in series with it. This wattmeter can be read with a mirror, if desired; but with 2,900 ohms in series with the pressure coil, it gives a torsion of  $2^\circ$  per watt on a non-inductive resistance. The series resistance is not wound with a looped wire as is usual in resistance boxes, because this method is not good, the insulation being apt to break down. A single wire was therefore used. When one layer was wound, the bobbin was reversed in the lathe, and the next layer wound in the opposite direction, a thin layer of insulation being put between the layers. This method secures absence of self-induction, and good insulation, as the beginning and end of the coil are kept well apart. The readings are taken by bringing the index back to zero by turning the suspension, so that the mutual induction of the coils is zero, as the coils are at right angles.

The self-induction of the pressure coil was not directly measured, as that would give us no useful information, as we do not know the variation of the current and pressure of air dynamos. They certainly do not vary harmonically, and at full load the pressure rises slowly and falls suddenly in each half period.

The wattmeter was therefore subjected to a severe test. Readings were first taken with direct currents on a resistance; readings were then taken on the same resistance with an alternate current. This resistance had very little self-induction, so that any self-induction in the pressure coil should lessen the reading, by making the current in the pressure coil lag, and also by reducing it. The reading with the alternate current was 2.1 per cent. less than with the direct. This figure is entered in the note-books, but though it is too small to matter in our work, it is larger than it ought to be. The next test was to measure the power taken by a coil with the same current and same pressure, but with no resistance and large self-induction. It is difficult to make up a coil with no iron core to take 50 volts and 10 amperes with no appreciable loss by resistance; we therefore took a hedgehog transformer, and measured the power taken by it. The reading was taken with 50 volts and 4.2 amperes. If the pressure coil had any appreciable self-induction, the reading would be considerable; it might, in fact, be anything up to about 200 watts. The least self-induction would increase the reading enormously. The reading was 11 watts, and the calculated loss by copper and iron in the transformer with only 50 volts on its secondary was  $10.3$ ; so the wattmeter is practically correct. Let it be supposed, however, that the loss in iron was really less than this, and that the loss was two watts less than the reading. This is an extreme assumption; but we may see how much such an error would affect our readings of the sample rings. The assumed error is 1 per cent. of the product of the pressure and current. Now, in the case of a closed iron circuit the power is about half the product; so this would lead to an error of 2 per cent. in the loss in the iron. In a closed circuit transformer the loss in iron is, roughly speaking, 10 per cent. at full load, and about 40 per cent., to take a low figure, taken over the day; so that the error would be 0.2 per cent. and 1 per cent. In the hedgehog form the loss in iron is about 1.5 per cent. at full, and 15 per cent. at all day loads; so the errors are .03 and 0.3 per cent. respectively, which are too small to matter. As a matter of fact, they are much less than the various errors of observation that creep into such work. Measuring the power in an open circuit transformer is also a most difficult case, for the least self-induction then gives rise to the largest error; in measuring the power in a closed circuit ring the errors are less.

We give a number of curves of permeability and of  $f \times d \times q$  per cubic centimetre for different samples of iron. These are practically the same as curves of  $f \times d \times h$ ; but  $f \times d \times q$  seems a better way of writing it, as  $f \times d \times h$  can scarcely be said to have any physical meaning, and has even had the effect of not suggesting that the reversal involves waste of energy; indeed, it seems to have rather disguised the fact.

In completing these curves some corrections have been made. The wattmeter absorbs some power itself, as the pressure coil circuit is led through the current coils. We might have compensated for this in one of the ways described to Section A by one of us in 1887, but in this case did not think it worth while. The Foucault current losses are also corrected. The losses in the wires themselves can be calculated with rigid accuracy, as explained in a paper on "Transformer Design," which one of us had the honour of reading before Section G last year. There might also be some loss by Foucault currents, due to imperfect insulation between the wires of the core. The insulation is, however, too good to allow this; in fact, the resistance between two wires, about an inch apart, runs into ohms, the measurement being seven ohms in the particular example taken. The losses by Foucault currents are frequently over-estimated by writers on the

subject. If the specific resistance of the iron is known, they can nearly always be calculated with much greater accuracy than they can be measured. The loss by the copper resistance is also allowed for in the curves. Though it is generally the practice to give all the steps in a paper like this, we think it better to give the results only; for, though the paper then looks less imposing than if full of curves and calculations, it is more likely to be useful.

We have not yet tested the same sample at very different frequencies to see if there is any time lag. From the comparatively small loss at high frequencies, it is not probable there is any appreciable time lag.

#### THE EFFECT OF OXIDATION ON THE MAGNETIC PROPERTIES OF MANGANESE STEEL.

By L. T. O'SHEA, B.Sc.

(Abstract of Paper read before Section A, September 9th, 1890.)

WHEN manganese steel drillings are oxidised they become magnetic. The development of magnetic properties being due to removal of manganese by oxidation, &c., to the magnetic properties of the oxide of iron (probably magnetic oxide) formed.

When the oxidised product is reduced in hydrogen the iron oxide is converted into metallic iron and the manganese remains as manganous oxide ( $MnO$ ). The reduced steel is now powerfully magnetic in virtue of the magnetic properties of unalloyed metallic iron.

During the process of oxidation the proportion of manganese to iron oxidised in a given time is only very slightly in excess of the proportion of manganese to iron in the original steel. The excess of manganese oxidised is in all probability due partly to the greater susceptibility of manganese to oxidation, and partly to the heterogeneous structure of the steel.

The following discussion was conjointly on Messrs. Swinburne and Bourne's paper on Testing Iron; Mr. Preece's paper on Magnets, and Mr. O'Shea's paper:—

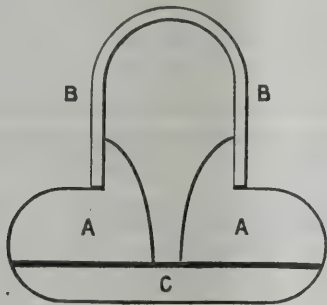
MR. PREECE said it was his intention to pursue the question of tempering, and he would be thankful for any suggestions. He was going to take a great number of samples of steel, raise them to different temperatures, and quench them in different cooling mixtures, such as oil, mercury, and water.

Prof. BARRETT remarked that he believed the exact temperature at which the heated steel was hardened by quenching, as well as the ratio of quenching, would be found to be important. If quenched short of the recalescent point no hardening ensued, and steel could not be tempered; hence the subject connected itself with the Committee, of which he was secretary, on magnetic and other phenomena connected with the recalescent point in steel. Dr. Ball in a recent paper read before the Iron and Steel Institute, said that both the tensile strength and magnetic properties of steel underwent a constant change when the steel was quenched at a too critical point; one  $700^\circ C$ ., and the other about  $1,300^\circ C$ . He hoped Mr. Preece would send specimens of his steel to the recalescent committee. In regard to Mr. O'Shea's paper, Prof. Barrett remarked it was Mr. Hadfield who first noticed that magnetic steel filings became magnetic in heating to whiteness. He had, through Mr. Hadfield's kindness, been able to make many experiments on this question, the results of which he had communicated to the Royal Dublin Society. Mr. O'Shea had shown that oxidation could hardly be regarded as sufficient cause, and he (Prof. Barrett) was inclined to think the cause was due to some dissociation or decomposition of the magnetic steel, whereby free iron particles were liberated. This effect did not occur in wire nor in filings wrapped in platinum foil; but this might be explained by the more rapid cooling which takes place in the filings, whereby the molecular state at a high temperature might be fixed.

MR. O'SHEA, in reference to Prof. Barrett's remarks on dissociation, pointed out that steel in the mass did not present those magnetic properties to the same extent as it did in the filings, and why should dissociation take place in the filings when it did not in the mass? His point was that oxidation did take place, but in the case of a mass of steel that oxide scaled off and left the metal perfectly free from oxide; whereas in the case of the filings the oxide remained with them, and they remained magnetic; then it was that dissociation took place. When the two were oxidised they first had the oxide of iron exerting its magnetic effect, and then, after reduction, the metallic iron exerted its magnetic effect.

Prof. PERRY said that there could be no more useful work than that which was being undertaken by Mr. Preece and his assistants, and as Mr. Preece subjected all the specimens to the same treatment his test was a fair one. But was this the same in the matter of tempering. He gathered that only one English specimen was tempered in mercury, and the Allevard specimen had not been tempered by Mr. Preece. He put it that this was really the important matter, the tempering, and he was glad to think that Mr. Preece intended to go thoroughly into the effect of tempering. Until that was done these results were useless. He (Prof. Perry) had tempered differently three similar specimens of the same steel. One in water, one in a little mercury, and one in a large bath of mercury. The third had an enormously greater retentiveness (he was not sure, but he thought it was three times) than the first.

He had the notion that steel must remain in a magnetic circuit of small magnetic resistance if it is to retain its induced magnetisation. That is, suppose a nearly complete ring of pieces of steel to have been magnetised, the magnetisation would be greatly diminished by taking them apart and replacing them. He obtained his great permanent induction by using the best form of magnet he could think of for that purpose, although it might be useless for all other purposes (fig.) B was a strip of glass-hard



steel, fitted to soft iron pole pieces, A A, C being a well-fitted keeper. The force required to pull off the keeper enabled the induction to be calculated. As the dimensions were great at right angles to the keeper, it was obvious that whether the keeper was on or off there was always extremely little total magnetic resistance.

Sir Wm. THOMSON said that Mr. A. Gray and himself had made a large number of experiments in the physical laboratory of the Glasgow University comparing steel from different makers. It was very difficult to get from the same maker constant results. Over and over again the specimens were found to differ exceedingly in magnetic quality from one another by 10 or 20 per cent though alleged by the maker to be as nearly the same as he could make them. On the other hand, they would get a very good specimen, and would ask for one like that, but had very great difficulty in getting what they desired. The specimens could not be too hard, and even when he asked for them to be glass hard, those sent did not come up to what he knew they ought to have. He returned them to be made as hard as they could be made, and only then did he get good results. He was exceedingly glad that Mr. Preece had taken the subject up, and he thought the results would be exceedingly valuable and interesting, not to science only, but to applied science. There was a great career for steel magnets.

Mr. GRAY remarked that the induction obtained by Sir Wm. Thomson and himself was about 12,000.

Sir Wm. THOMSON said that they reckoned the standard result for the very best steel used to be 100 C.G.S. intensity of magnetisation per gramme weight; that corresponded to only about 10,000 induction, and he was pleased to see the results put forward by Mr. Preece were enormously better than what was supposed to be obtainable. C.G.S. per gramme was a very convenient way of putting it. In connection with his experiments he multiplied by the specific gravity of steel 7.8, so that 100 magnetic moment per gramme gave 780 magnetic moment per cubic centimetre intensity of magnetisation, and that was the best way of putting it. This was the highest intensity of magnetisation that could be obtained.

#### THE LINEFF ELECTRIC TRAMWAY.

By GISEBERT KAPP.

(Read before Section G, September 8th, 1890.)

The following is an abstract of the paper read, a fuller description was given in the ELECTRICAL REVIEW for July 4th, 1890.

The conductor consists of bare copper strip or cable, and of iron strip. The latter is galvanised so as to protect it from rusting. It lies on the copper conductor, and both are enclosed in a sealed channel formed of asphalt. The copper conductor rests upon the bottom of a trough made of a succession of glazed tiles, and the cover to this trough is formed by the lower flanges of iron rails arranged in short sections so as to be insulated from each other. The head of one rail reaches up to the surface of the road, the head of the other is cut off, and this rail is therefore completely buried in the asphalt. The surface rail, which may be arranged alongside one of the ordinary tram rails or in the centre of the track, is in electric and magnetic contact with an electro-magnet carried under the car. This magnet runs upon the surface rail on wheels which form its north and south poles. The distance of the wheels is greater than the length of a section of insulated rail, so that successive sections become oppositely magnetised. This causes the iron strip immediately below the magnetised region to be attracted upwards, and thus come into contact for a length of several feet with the under side of the two sectional rails. At the same time the iron strip to both sides of this region remains in contact with the copper conductor, and forms thus an electrical connecting link between the copper conductor and a few sections of insulated rail under the car. The current passes from the surface rail through the body of the electro-magnet (which is insulated from the body of the car) into the motor, and finally into the ordinary tram rails and earth in the usual manner. The electro-

magnet is energised by a shunt current obtained from the main conductor, but to provide for the possibility of dropping the strip from some unforeseen cause, there is placed on the electro-magnet a third thick wire coil, which can at all times be energised by two storage cells carried on the car, and thus the strip can be picked up and the main circuit again established if it should have been accidentally interrupted. I may, however, at once state that during some tests which I made on an experimental line of this kind, and which lasted over several days, there has been no need for the picking-up battery, as the current was never lost. The way in which Mr. Lineff makes use of magnetic lines of force to effect the attraction of the iron strip deserves attention. It might perhaps be thought that the most direct, and therefore the best, way of utilising the lines of force would be by one single line of sectional rail, through which there would be longitudinal magnetic flux corresponding with the fore and aft position of the poles, and attraction of the strip at every gap between two sections. Experiment has, however, shown that this apparently direct way is by no means the best way, and that far more satisfactory results can be obtained by arranging a more roundabout course for the lines of force. This is attained by the employment of the subsidiary or buried rail, the gaps in which do not exactly correspond with those in the main or surface rail, but are shifted forward by a certain amount. In consequence of this arrangement, the buried rail acts as a kind of magnetic bridge to successive portions of the surface rail, and this action takes place in two ways, one direct and the other indirect. The direct way is longitudinal, and does not affect the strip at all. The indirect way is both longitudinal and transverse, the latter passing several times through the strip. The buried rail is a rather imperfect bridge to the lines of force traversing it longitudinally, because its magnetic resistance in that direction is great, but this rail forms a very efficient bridge for lines passing through it transversely, owing to its lower magnetic resistance in that direction which includes the strip. The flow of magnetic force transversely is therefore that which effects the attraction of the strip, and may be represented as a series of magnetic stitches passing to and fro between the two sets of rails and the strip.

#### DISCUSSION.

Major-General WEBBER said they were very much indebted to Mr. Kapp for his description of the system. It was one which, he thought, met, in a remarkable way, a want which had been felt for a long time, assuming, of course, that nothing but underground conductors would be allowed by the authorities. Several engineers of the speaker's acquaintance had been directing their attention to the means of picking up contact in a duct underneath the surface, which contained the copper conductor, and they had, he must confess, fallen short of the ingenuity displayed in the system suggested by Mr. Lineff. The description he had just heard showed that they might see daylight in that direction. He should like to draw the attention of Mr. Kapp to one or two points, on which the meeting was entitled to a little further information. Before proceeding further, the speaker pointed out one or two things, on the diagrams, which were not quite clear. In the main, however, the diagrams gave a most excellent and graphic description of the way in which the magnetic field in the rolling magnet excited the rail. He felt, however, that there was absence of information as to the pressure which actuated the motor in the car. Supposing the pressure to be five volts, he failed to see that it was secure in preventing the rail remaining in contact after the passage of the car travelling at the rate of about 15 miles an hour, not particularly on the lines, but in the subways. Although the people did not walk in the subways, there was still a liability to accident if there resulted a permanent contact between the strip and the iron rails. In the absence of that information, he would also like to ask the size of the copper conductor to the work which requires to be done. He must confess some doubt as to the insulation of the conductor as shown on the diagram. Though it might be fairly good, there was the different condition of highways, &c., and the question of weight, which at some time might break the whole thing to pieces. In conclusion, the speaker referred to the competition between the use of cable and electrical traction, considering there was a large field for work.

Mr. PREECE said he had only to add to what Mr. Kapp had said by stating that he had inspected the working of the system near Chiswick, and he corroborated every word that the reader of the paper had said. His (the speaker's) fears of practical success of the system were, principally, that there might be a failure of contact; but this was got over, first, by having a very broad strip and very lengthy contact, and also by the fact that the flexible iron conductor is galvanised, and, therefore, always clean. Moreover, the galvanisation on the surface has exactly the same effect as the insertion of pieces of paper on the pole pieces of electro-magnets. Of all systems produced, this had an air of practicability about it, but it would be quite impossible to give a definite opinion upon it until it had received the test of actual practice. His impression was that the tramway company which served the district about Kew would lay down three or four miles of the system, and he hoped when they met at Cardiff next year that Mr. Kapp would be able to tell them the results of an absolute practical test.

Prof. ARNOLD LUTON said some remarks on the insulation of the rails and the falling of the strips, but his remarks were indistinctly heard.

Mr. SELLON said there were one or two questions he would like

to ask. They had not had any detail as to the cost, which was naturally the first thing of a tramway engineer. Although Mr. Kapp had said the system could only be an advantageous system in the particular districts, because no other would be allowed in the districts, he did not see why other electric systems should be thrown out, because Mr. Kapp wished to introduce Lineff's system. He would have been glad if Mr. Lineff had joined hands with them in the late fights in Parliament against telephone companies. If the telephone companies were going to have their clauses introduced into their bills for electric traction, neither Mr. Lineff's system nor any other system by which the return wire coming through earth could be used. One great difficulty he saw with the system is whether the contact is always going to drop directly the car passes over at great speed. He desired before sitting down to draw Mr. Kapp's attention to the telephonic clauses, and he asked the question as to the cost per mile and its absolute efficiency from its generating station at the car motor.

Prof. EWING said how much one must admire the exceedingly ingenious method by which Mr. Lineff had solved the fundamental magnetic difficulty in the problem. They had here a strip of sufficient amount of mechanical force; the action upon the iron strip occurred only when the iron rail above it was interrupted, and if the longitudinal action had been made use of, it would have been necessary to cut a longitudinal rail into an inconveniently large number of sections, but by the exceedingly simple device of employing a supplementary rail cut into comparatively long sections, Mr. Lineff had succeeded in grasping his conductor not at one or two points only, but almost the whole length under the car. It was impossible not to admire, from the magnetic point of view, the exceedingly ingenious solution of the difficulty. Something after the same system had been before the public as a proposal for a number of years—namely, the system originally introduced by Messrs. Ayrton and Perry having a thoroughly well insulated conductor underground, which was to be connected when the car passed with successive sections of a not so well insulated conductor serving as a service conductor. This was exactly what Mr. Lineff did, though, of course, in a very much more satisfactory way than the mechanical methods practised by Ayrton and Perry.

Mr. SWINBURNE wished to emphasise what Mr. Sellon had said. It was an important question that of the telephones, and one hardly knew what would happen unless the thing could be settled. Insulated returns were insisted on, which was a tremendous drawback to electric traction.

Major-General WEBBER said that, with regard to the telephone, they could next year dismiss this fear from their minds, for he had every reason to believe that almost all the telephone systems in this country would be served by metallic returns and not by earth returns, in which case it would not be necessary to insist on such clauses.

Mr. KAPP, before entering into the technical questions, said he would reply to Mr. Sellon. He wished it to be clearly understood he had not any interest whatever in bringing forward the Lineff system. He placed before them the result of careful investigations without comment. He did not wish, as Mr. Sellon had said he wished, to throw out any other system of electric traction; for his part, he would be glad to see it go ahead a little faster. English Town Councils (and they must reckon with the powers that be) would not tolerate the overhead wires, and, consequently they must work with the underground or some other system, and often the Town Council, as was the case in the Hammersmith Vestry, had so tender a regard for cyclists, as to prohibit the use of the slot in the street. The difficulty in disturbing the telephone wires were overcome by working the tram lines on the three-wire system, the down line connected with the positive and the up with the negative, and the third wire put to earth, which resulted in a differential current, which was small, going to earth. He was sorry that he did not explain that the current went back to the station in the usual way; but, of course, they could have a second conductor if they wanted to work a close circuit. The system of duplicating the telephone wires was far preferable. They all knew the bad telephones in London, and they would be better if that plan were adopted. In regard to the question asked by General Webber about the strip remaining in contact, he was sorry he did not make it quite clear; the strip did not remain in contact. He had a fear that the residual magnetism would be enough to heat the strip, and another fear was the main wave under the car, by some way jerking the strip, would induce subsidiary waves and make a contact; but he (the speaker) had tried in many ways to make this contact, but had not succeeded. General Webber evidently thought the contact would be due to the voltage, but the residual magnetism did not prolong the contact, which was the reason that galvanised covering was used. As to the enquiry about insulation, what he had put on the blackboard is the line as it was actually built, but since the line had been finished Mr. Lineff, who had a most ingenious mind, had improved the general arrangement of the surface, and hoped thereby to get a very much higher insulation. As to failure of contact, a part of Mr. Lineff's work was to provide means whereby the strip could be drawn out and a new strip drawn in, if it were found the strip fell down. A gentleman on the left asked how this one-car system could be worked. The system of working tramways most in use was known as the parallel working system. The conductor which brings the current was tapped by each car, which drew off sufficient current to give motive power; but there was nothing to prevent the second car tapping the said conductor. It was a well-known system of

tramways, which had been used in many cases. An ascending car would tap off a little more electric fluid, if he might be allowed to use an unscientific term, and a descending car may tap off a little less, or it may give back a little, if the descent was strong enough. As to whether there would be any noise from the strip, there would be absolutely none whatever. As to the question of cost, he knew what Mr. Lineff's estimate was, although he did not know whether it was correct, the cost would be £2,000 a mile, which was a little heavier than overhead conductor, but not much.

#### COLUMN-PRINTING TELEGRAPH.

By F. HIGGINS.

(Abstract of paper read before Section G, September 9th, 1890.)

This apparatus was originally patented 10 years ago, and is now being practically introduced for the transmission of intelligence in this country.

The receiver, which is entirely automatic, consists of a type wheel and frame carrying the paper sheet. The former derives the motive power for its rotation from a train of wheelwork and a weight, and the latter from the battery at the sending end.

The type wheel is displaced laterally, after each print, by means of a screw, and upon completion of a line of printing is released and returned to zero by a spring which has been wound up by the movement of the printing lever.

One train of clockwork is employed, and the motive power for printing, feeding the paper, and traversing the type wheel, is supplied by the printing electro-magnets.

About 20 of these instruments may be introduced into the circuit of a single line of wire, and any number may be worked from one transmitter. The type rotates at any desired speed (from 100 to 150 revolutions per minute), and the same signals operate both the type rotation and the printing, the difference being that the signals for printing are longer than those operating the escapement, in order to afford time for the establishment of the full strength of the current in the circuit, and to overcome the inertia of the comparatively heavy parts of the printing mechanism.

The other operations of synchronising, spacing between lines, &c., are determined by the angular displacement of the type axis with respect to its zero position. The transmitter is driven by an electro-motor, the speed of which is kept uniform by an electrical governor. A counter upon the transmitter announces to the operator when a line of type has been filled. From 1,800 to 2,000 words per hour would be the maximum speed. Five thousand words can be received without attention, and the paper supply is sufficient for the reception of 30,000 words.

#### THE EFFECT OF DIRECT AND ALTERNATING PRESSURES ON THE HUMAN BODY.

By J. SWINBURNE.

(Read before Section A, September, 1890.)

As there seems to be some doubt as to the relative effects of alternating and direct currents, a bridge which measured the resistance of the patient under various pressures was made up. Fuller readings, which agreed with the first as nearly as such very uncertain readings can be expected to agree, were afterwards taken by putting on different pressures and measuring the current; the resistances being calculated. The alternating currents were measured with a non-inductive wattmeter arranged as an ammeter, the pressure being taken with a hot wire voltmeter. The tests were taken from hand to hand, the hands being dry or wet with dilute acid in the case of direct currents, and dry in the case of alternating. It seemed to make little difference in the case of alternating currents whether the hands were wet or dry. There was no need to measure the resistance from hand to foot, as that obviously would depend on the boots worn.

Human Resistances; Hand to Hand..

Current.	Name.	Hands.	Volts.	Resistance.
Alternate ... ..	A	Dry	18	950
Continuous ... ..	"	Dry	50	8,000
Continuous ... ..	"	H <sub>2</sub> SO <sub>4</sub>	50	8,010
Alternate ... ..	B	Dry	10	1,330
Alternate ... ..	"	Dry	18	1,110
Continuous ... ..	"	Dry	50	6,660
Continuous ... ..	"	H <sub>2</sub> SO <sub>4</sub>	50	1,930
Alternate ... ..	C	Dry	18	620
Continuous ... ..	"	Dry	50	5,400
Continuous ... ..	"	H <sub>2</sub> SO <sub>4</sub>	50	1,980
Alternate ... ..	D	Dry	18	1,090
Continuous ... ..	"	Dry	50	10,000
Continuous ... ..	"	H <sub>2</sub> SO <sub>4</sub>	50	16,000
Continuous ... ..	E	Dry	50	6,700
Continuous ... ..	"	H <sub>2</sub> SO <sub>4</sub>	50	1,100
Alternate ... ..	"	Dry	18	1,300
Alternate ... ..	F	Dry	18	750
Continuous ... ..	"	Dry	50	3,320
Continuous ... ..	"	H <sub>2</sub> SO <sub>4</sub>	50	1,710
Alternate ... ..	"	Dry	54	670

In the above table the direct pressure is always 50 volts. Any of those tested could have taken more than this; but even with 50 volts the discomfort is extreme if the contact is made and broken. The maximum current taken was .04 ampère by E, whose resistance is low. He could have taken more if available. All the resistances are much lower than those obtained by the usual method of measuring with a bridge and one or two cells. Probably polarisation then interferes.

When the direct current from 50 volts is concentrated in one finger it feels hot, though especially as the current is reduced, there can be no appreciable heat generated.

The most curious thing is the very low effective resistance to alternating currents. The alternating pressure could be regulated by steps of 4.5 volts. Out of the five subjects tested not one except F could stand more than 18 volts alternating, the maximum effective current taken being .03 ampère. F seems abnormal. He took 54 volts and nearly a tenth of an ampère. D, who has the highest resistance, was the only lady tested. Though, with the exception of F, none of us could take more than 18 volts alternating with a good contact, I have several times touched 600-volt alternating terminals lightly. They were given by a Siemens machine used for "flashing" lamps. Before I took charge of the factory containing it, I am told several of the girls had shocks from the same machine. Spring switches, which demanded both hands to give any current, obviated danger to them afterwards. I have also had a very severe shock from a 100-volt Ferranti. Though 18 volts was as much as we could take, there was no difficulty in letting go.

These results bear out those of Messrs. Lawrence and Harries + as to the relative resistance to alternating and direct currents, but the figures are entirely different. They never found anyone take over 10 milliampères, while F took 90 milliampères alternating, and E, a workman, took 44 milliampères direct, and could have taken more if available.

13799. "Improvements in electrical signalling apparatus." H. H. LAKE. (Communicated by the Electric Secret Service Company, United States.) Dated September 2. (Complete.)

13845. "Improvements in and relating to the propulsion of tramway vehicles or boats by means of electricity." J. L. HUBER and L. J. MAGEE. Dated September 3.

13886. "Improvements in and connected with the distribution of power by alternating electric currents." J. SWINBURNE. Dated September 4.

13897. "Improvements in apparatus for the safe deposit of milk and other articles; for electrically announcing the same, and for saving and registering time." C. E. KELWAY and A. KAPADIA. Dated September 4.

13905. "Improvements in and relating to the welding of metals by electricity." M. W. DEWEY. Dated September 4. (Complete.)

13921. "Improvements in electric lamps." A. SCHANSCHIEFF. Dated September 4.

13943. "Improvements in power conduits for tramways or railways and in electrical connections therefor." C. T. B. BRAIN. Dated September 4.

13987. "An electricity counter." J. RICHARD, F. RICHARD, and G. RICHARD. Dated September 5.

14050. "An improvement in electrical cut-outs." SIEMENS BROS. AND CO., LTD. (Communicated by Siemens and Halske, Germany.) Dated September 6.

14054. "Improvements relating to apparatus for converting alternating electric currents into continuous currents." W. S. RICHARDS and G. B. JAMES. Dated September 6.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

10082. "Improvements in insulating bases for electric switches, fuse blocks, ceiling plates, and the like." G. BINSWANGER. Dated June 20. 8d. The inventor provides china bases with projecting walls vertically disposed on the front, top, or outer surface of said bases, and forms these vertical walls with perforations or holes through which the metal screws are passed for securing the metal conductor. 5 claims.

11046. "Improvements in cores for electrical apparatus and the method of forming the same." W. P. THOMPSON. (Communicated from abroad by The Westinghouse Electric Company, of America.) Dated July 9. 8d. Consists in first stamping from sheets of suitable magnetisable material such as soft iron, plates of the required size and form from which to build up the core; then subjecting the plates to an annealing process which is carried to such an extent that a thin film of oxide is formed over their entire surfaces, and over, also, the burrs or rough edges produced by the stamping process; and afterwards building up the core by placing such plates side by side. 4 claims.

11242. "Improvements in dynamo-electric, magneto-electric, and electro-dynamic machines." SIEMENS BROTHERS & CO., LIMITED. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 12. 11d. Relates to improvements in dynamo-electric, magneto-electric, and electro-dynamic machines, such as were described in the specification to patent No. 1447, of 1881, wherein a continuous current was produced by separate electrical impulses generated immediately after one another at different parts of the machine, that is to say, in different magnetic fields, the number of rotating bobbins in the form of solenoids being different from that of the magnetic fields, so that the former did not all pass the latter simultaneously, but at successive intervals. The present improvements relate to a modified form of the bobbins (which formerly were made as solenoids), wherein these are made of a zig-zag form with radial active and circular inactive parts. 2 claims.

11296. "Improvements in appliances for setting up or taking down electric incandescent lamps." The Honourable H. DUDLEY RYDER and H. E. DOPSON. Dated July 13. 8d. In order to enable an attendant to so place the stem of an electric incandescent lamp into the socket which is to hold it without the attendant having to get into close proximity to the socket, the inventor provides a holder within which the glass of the lamp can be held and be retained by friction to some extent from turning therein. 3 claims.

11332. "An improved material for the construction of bearing surfaces specially applicable to the brushes and commutators of dynamo-electro machines." K. W. HEDGES. Dated July 15. 8d. Relates to the manufacture of a new material for rubbing or bearing surfaces composed of a mixture of carbon and mica or steatite. 2 claims.

11501. "Improvements in the construction of electric fuzes and detonators, and in the method of and appliances employed for manufacturing the same." P. WARD and E. M. GREGORY. Dated July 18. 8d. Has for its object to provide a means of more completely protecting the fuzes from the destructive influence of moisture, heat, climatic and other influences. 3 claims.

## NEW PATENTS—1890.

13319. "Improvements in electric bells and motors." J. TOWNLEY. Dated August 25.

13337. "Improvements in electrical contacts." G. FORBES. Dated August 25.

13357. "Improvements in electro-motors." A. SIEMENS. Dated August 25.

13358. "Improvements in the means for driving winches and other winding machinery by electrical motors." A. SIEMENS. Dated August 25.

13359. "Improved means for carrying electro-motors on electrically propelled cars or vehicles." SIEMENS BROTHERS & CO. (Communicated by Siemens and Halske, Germany.) Dated August 25.

13371. "Improvements in electric bells and indicators." H. J. HARRIS and W. H. POWER. Dated August 25.

13421. "Improvements in apparatus for working or welding metals electrically, and in the method of effecting the same." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated August 26.

13485. "Improvements in fittings for electrical glow lamp conductors." W. WHITE. Dated August 27. (Complete.)

13525. "Improvements in electricity meters for alternating or interrupted currents." G. HOOKHAM. Dated August 28.

13535. "Improvements in electrical alarms." N. G. THOMPSON and G. H. REW. Dated August 28.

13549. "Improvements in and relating to converters of alternating currents." R. KENNEDY. Dated August 28. (Complete.)

13570. "Improvements in and relating to telegraphic apparatus." B. EGGER. Dated August 28.

13635. "Improvements in or appertaining to electric welding." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated August 30. (Complete.)

13636. "Improvements in electric welding." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated August 30. (Complete.)

13683. "Improvements in electric switches." O. ROMANZE and F. W. WHITE. Dated August 30.

13751. "Improvements in electric switches." C. W. HUNTINGTON. Dated September 2. (Complete.)

13770. "Improvements in systems of electrical distribution of light and power by means of transformers." W. F. TAYLOR, G. B. LUCKHOFF and E. H. HUNGERBUHLER. Dated September 2.

13774. "Improvements in electrical connections." F. C. DUNAWAY and F. W. DUNAWAY. Dated September 2.

13791. "Improvements relating to compositions and devices for use in the manufacture of filaments for incandescent electric lamps." H. H. LAKE. (Communicated by V. M. Hobby, United States.) Dated September 2. (Complete.)

14342. "Improvements in or relating to accumulators or secondary batteries for use in lighting railway carriages and other conveyances by electricity." J. C. MEWBURN. (A communication from abroad by La Société Anonyme pour le Travail Electrique des Métaux, of Paris.) Dated September 11. 8d. Relates essentially to:—1. A trough lined with a vessel of insulating material, and hermetically closed. 2. Accumulator plates having a special appendage either for individual grouping of plate to plate of the same category, or for the grouping of apparatus to apparatus. 1 claim.

14656. "Improvements in electric glow lamps." A. BERNSTEIN. Dated September 17. 6d. The current is conveyed from two platinum wires which are sealed into the glass bulb. From the platinum wires the current passes to the carbon by means of stout conducting wires, which are generally made of nickel. These conductors are bent in such a manner as to almost approach each other at a given point, and they are held rigidly apart by means of a glass or other insulating piece at their lower end, near to the point at which the conducting wires are attached to the platinum wires. A part of one of the conducting wires is hammered out flat, and thereby forms a spring, which has the tendency to produce a contact between the conducting wires at their bent portion. The conducting wires are held rigidly apart at their two extreme ends, first by means of the glass insulating piece, and, secondly, by means of the carbon rod, as long as the latter is intact. If, however, by the action of the current the carbon should be destroyed, then the conducting wire, which is flattened out as a spring, will follow its tension and produce an automatic short-circuit by placing the conducting wires in contact. 2 claims.

17762. "Improvements in electrical switches." F. L. RAWSON and W. WHITE. Dated November 7. 6d. The inventors enclose an electrical switch of any suitable form in a case of metal or other watertight material having stuffing boxes in its sides, through which pass the insulated conductors to the switch terminals. The top of the case is conveniently formed as a cover, which screws on to the lower part with a face and groove for packing to render the joint water or gas tight; in the centre of this cover is a stuffing box through which passes the handle spindle. This handle spindle has the handle attached to it outside the cover stuffing box and inside it is formed so as to engage with the switch contact arm through an insulating piece when the cover is in place; but this coupling is free and is arranged so that the cover with the handle spindle and handle is quite free to be taken off without interfering with the switch contact arm. 1 claim.

18897. "An improved quick-make and quick-break switch for electrical purposes." J. G. S. CUNNINGTON. Dated November 25. 6d. Consists of a lever and spring, which in the first part of their movement are acted upon or controlled by the handle of the switch. In the remainder of their movement the spring acts on the lever to which one end is attached and draws the lever forward independently of the handle of the switch. 3 claims.

19129. "Improvements in electric dry batteries." C. R. BONNE. (Communicated from abroad by H. Meinecke, the younger, of Breslau.) Dated November 28. 4d. Consists in saturating the carbon electrode in sulphate or nitrate of silver, and in bringing it in contact with sal-ammoniac or with other liquid or substance saturated with liquid in order to form chloride of silver, which is deposited in finely disintegrated particles on the carbon. 1 claim.

## THE POSTMEN'S STRIKE.

CONCEIVED in frenzy, characterised by indecision and terror, and carried out in anything but a spirit of general unanimity, the postmen's strike appears, for the time being, to have drifted into the leeway of current topics. The variety and chameleon-like changes in these latter-day struggles between capital and labour are, doubtless, responsible for the little notice taken of the terrible position to which the unwise and unhappy postmen now find themselves reduced; but we are glad to note that the subject has not been altogether lost sight of by the Press, close upon 400 men are realising now all the terrible disadvantages and misery of an unsuccessful strike, their position rendered all the more gloomy from the fact that they are reduced to a much lower level than that touched by artisans and tradesmen who adopt similar courses in fighting for the cause of labour.

When the working man strikes, which he does almost invariably as a matter of business and not of sentiment, there is no avenging angel of monopoly to bolt the door for ever in his face, and to enact a decree of commercial banishment against him. Hard as the fight may be, bitter as recriminations oftentimes are,

yet the character and manhood of the individual are, generally speaking, in no way involved, and on the settlement, successfully or unsuccessfully, of differences between master and man, the old faces and the old hands "go in," and if there is not exactly joy in the manager's office, at all events, there is no desire to indulge in reprisals; and this is as it should be.

Another most important feature is that the tradesman or artisan need not tie himself to any one shop, factory town, or district. His passport is his tool-bag, and his ability as a workman is a certificate which will carry him round the whole wide world.

He makes light often of the fact that he has been a decade, or, perhaps, two, with some respected master. His departure from the old bench means no loss of pay or social position. It may be the result of circumstances over which neither he nor his employer has any control; besides, few good men remain idle long. The master, indeed, may pay him off through slackness of trade or through the closing of contracts. But it may be that the next influx of work will find him back at his bench, if he has not "gone in" elsewhere. Some men, indeed, do not care for permanent situations.

As much is to be learned by travelling, so will intelligent men often find a means of coming to the front in their callings through the experience begotten of a discreet course of changes from shop to shop or from factory to factory.

We mention such matters to show that to the workmen a strike—particularly a local one—is not such a hopeless and heart-sickening ordeal as that through which the postmen who went on strike are now so unhappily going. Many will say that these things were surely palpable to the postmen, or ought to have been made known to them, when they talked of striking. We fear that they were not overburdened with good advice at any stage of their proceedings, and it is best to consider these things as they were and are rather than as they should have been.

As the post office system generally is a huge government monopoly, no such resources as are available to the "working man" fall to the lot of the postman or the letter sorter. It is surprising that the Postmen's Union should have lost sight of this tremendous fact—a fact which, we are quite sure, inspired the utterances of the Postmaster-General when he spoke of the danger that extreme action would engender to the men themselves. Hand in hand with the question of general monopoly goes that of the character of the individual. The action of the 400 strikers may officially be held to have affected and even tarnished their characters. Here we realise fully the effect and power of officialism on the individual. Though few will approve of the postmen's strike, we doubt if they will say that these unfortunate men are any the less manly, honest, and honourable than before. Indeed, we feel that the impulse of their hearts outdid the wisdom of their heads, or that their frenzied zeal overcame their discretion. The eulogies passed on those who showed their "devotion" to the department may be considered as of little value. We refer now to the men at the General Post office, of whom the Postmaster-General spoke in terms of almost unqualified praise. These "devoted," heartless creatures had all along acted as decoys to their less sophisticated comrades—they were the enthusiastic men, the street paraders, the hooters and groaners and those most noisy in calling out "Strike! strike!" at their public meetings. The district men, who comprise almost the entire body of strikers, beguiled by such will-o'-the-wisp demonstrations, have now to bear their own sins as well as those of the "devoted" band. The encomiums of the Postmaster-General will not go far to ease the stings of conscience in their loyal hearts; but, possibly, they may have sacrificed even conscience at the altar of "devotion."

For such men few will feel any pity, and it is not too much to say that a large measure of responsibility attaches to their wicked and unmanly conduct.

Taking all these circumstances into consideration, it

is not surprising that great disappointment was expressed on the publication, some weeks ago, of the correspondence between the Postmaster-General and an ex-M.P. on the subject of the re-instatement of the erring and wretched postmen. A few of the younger, the Postmaster-General pointedly said, would be reinstated, subject to certain conditions—and such conditions. The older men were to have no mercy. Their shortcomings, we gather, and those, probably, of the “loyal” section, would be concentrated within themselves, and they would be punished with the utmost severity. This appears worthy of bracketing with the severest samples of Roman law—ancient and effete. Disappointment became greatly accentuated when reports appeared last week of the continuance of what a contemporary called a career of “vengeance,” and the dismissal of merely suspected men—postmen and sorters.

The reinstatement of the whole of the already severely punished men would not be regarded by civilised persons as any sign of weakness and indecision in the administration of the General Post Office. That argument is sometimes applied to savages, but never to any race of intelligent and thoughtful people; therefore the Postmaster-General has no need to apprehend any misunderstanding on that score from futurity. We mention this as it is put forward as a reason for making such a great number of examples. There will be no more strikes in St. Martin's-le-Grand, we feel very sure. The Postmaster's argument is best met by reminding him that each case should be settled on its own merits, and his anxiety with regard to the future may be left to the future. Futurity will look after itself, and will be none the worse for a noble example, and one in accord with philanthropic sentiments many times expressed. The objection that there are no vacancies is one that will not hold water, as we heard months ago from a reliable source that the service is greatly under-manned, both in town and in country.

The Postmaster-General has drawn comparisons between the methods of controlling men in the General Post Office and those generally adopted by employers of labour, but no employer of labour possesses the autocracy of a Postmaster-General. No employer of labour could work the social ruin of 400 men because they had participated in a strike, but, strangely enough, a Government monopoly renders this method of commercial excommunication, with its terrible consequences, comparatively easy of fulfilment. Without going into commercial comparisons which might not altogether redound to the credit of the post office, we can still lay a plea for the exercise of that unstrained mercy which “droppeth as the gentle rain from heaven,” and we trust it will be taken up throughout the country.

There are those connected with the administration of the General Post Office who, judged by their platform orations and their recent careers are inspired by high Christian sentiments towards all ranks and conditions of men. They have advised their hearers again and again to forgive “even unto seventy times seven.” These gentlemen are surely qualified in the fullest degree to urge the Postmaster-General to display largely those grand and divine qualities which go to build up the public and private reputation of a noble-minded English gentleman. No one is more powerful on such subjects than that courtly and soldierly-looking gentleman, the Secretary to the Post Office, and we cannot believe that he would not practice what he has so often and so ably preached. He has now a splendid opportunity of reaping a harvest of heartfelt gratitude.

The Postal Jubilee glory of 1890 will be all the brighter if that “quality of mercy” of which the immortal Bard of Avon has pealed forth such glorious and sublime harmony to the heart and mind, is observed now fully and compassionately to the heart-wrung and sorrow-stricken men who have already received a terrible lesson, and whose thoughtless actions have plunged happy homes and loving wives and relations into an abyss of misery and cruel destitution.

## CORRESPONDENCE.

### Fire Risk Rules.

I have read with great interest your different articles in the REVIEW *re* Fire Insurance Rules, and I can testify as to the arbitrary measures sometimes resorted to, which makes it every day more apparent that one solid and sound rule should be adopted and rigorously kept by all contractors; an illustration follows why this should be so.

A little time ago I made out an estimate and specified for a certain class of cables which would be guaranteed to have an insulation resistance of 600 megohms per mile. Having previously used a large quantity of this said cable, I knew its good quality; nevertheless, after my estimate had been accepted, my client wished that all the materials should be inspected and passed by a certain well-known fire insurance office. Of course, I gladly consented, never dreaming of the amount of trouble and expense this meant. Their inspector said nothing but Silvertown cables would do, and condemned almost everything that was shown.

Now, every man is guided by his own sense, and all these articles had passed on an installation not insured by the said office, and received a splendid report.

My complaint is this: after a contractor has given a price, not necessarily a low one, and then finds that the fire office requires material so much higher in price, the only thing he can do is to go to his client and tell him or her the price will be so much more than you expected, owing to this interference; in nine cases out of ten they would think otherwise, and throw over the whole thing, saying you give a price and cannot keep it. My question is, Why?

A. J. Howes.

September 15th, 1890.

### Elmore Copper Company.

I should esteem it a great favour if you would kindly answer the following enquiries in your next issue. Do you know anything about the commercial value of Elmore's process for manufacturing tubes, wires, &c.? Is the company doing any business, and are their articles likely to be adopted and the business to be a success?

Thanking you in advance for any information, I enclose my card and remain

A Young Electrician.

September 12th, 1890.

[The process seems to be a valuable one for tubes, cylinders, &c., but we see no advantage over other unpatentable processes for producing high conductivity wire. It is impossible to say what the company is doing other than putting down plant and floating sub-companies, the business should be a success, but is probably much over-capitalised.—EDS. ELEC. REV.]

### Permanent Magnets.

The article published in your last issue on above subject involves considerable misapprehension. I beg to submit a few facts on this matter.

The so-called French steels of Clemandot and Marchal are methods of treating magnet steel of any make. M. Clemandot's is by great compression and subsequent magnetising, without any hardening. Under this process, my steel and others gives similar results.

Marchal is a small but skilful magnet maker, who is using English steel supplied by the successor in my French business. This gentleman is now in Sheffield, and tells me he has his own system, both as to the solution employed and the means of regulating the

heat of the steel. He also considers Clemandot's process worthless.

The only French steel I have found employed in instrument work at Paris is that known as "Alevard," which firm also supply finished magnets.

About ten years since I introduced my quality in France, and found no difficulty in competing with the Alevard, as mine was both more easily worked and more powerful magnetically. The same authority informs me that, after M. Charrier's decease, the Alevard mark has been irregular, and though sometimes as good as any, is also at times inferior.

I supplied several of the principal consumers at Paris for years, and since ceding my trade there the same customers have continued to use English steel from my successor.

There are several magnet steels made here now, which give passable results, but a great deal depends on the manipulation of the steel, viz., obtaining the best heat and controlling it, unless the heated magnets are brought in contact with the water at exactly the same temperature there will be great variation in the induction. A recent case occurred where  $2\frac{1}{4}$  times the induction was obtained when the steel was treated in a better way, and from this cause delicate experiments such as those detailed in the article may be largely invalidated.

As scientific men are supposed not to know much about magnetism, it can scarcely be expected that mere steel makers should either. It is surely the province of electricians and chemists to tell us what is wanted, and then it will be our function to produce it.

We have no means of conducting delicate electromagnetic experiments, but must look at it as a matter of the compositions of the material. We employ certain constituents which have been varied in proportion, and have had considerable expense in analyses and test magnets, with the result that what one consumer says is excellent another reports worthless; for instance, one of the marks comes out badly in the experiments of the article, which my friend from Paris says is excellent steel, if properly handled, and that Marchal would make it come out first class. If electricians are not satisfied with the magnet steels as now supplied, let them formulate the composition of a perfect material for the purpose, so that we may know what to produce.

There is nothing said in the article as to the chemistry of the steels; but that is the manufacturer's point of view.

As to English magnet steel having deteriorated, there is, practically, only one French magnet steel, which is certainly not superior, if equal, to several produced here.

I may add that good magnet steels are produced in Styria and Germany; but as those are not alluded to in the article, need not be further noticed.

G. P. Wall.

September 15th, 1890.

#### An Answer of Thanks.

Many thanks for your leading article on my labours. You have declared your adhesion to the main point—"that there is only one kind of electricity." For this adhesion to my theory of electricity I have sincerely to thank you, but in doing so, you must excuse me for doing my duty toward another party. By God's kind hand I had a pious mother, who taught me from my earliest days to put my trust in God and His promises, one of which is, "Commit thy works unto the Lord and thy thoughts shall be established" (Prov. xvi., 3); another is, "Trust in the Lord with all thine heart and lean not unto thine own understanding; In all thy ways acknowledge Him and He will direct thy paths" (Prov. iii., 5). I trusted in these promises and God has graciously fulfilled them in my case. He has made you the instrument of giving me the opportunity of thanking Him publicly for the gracious fulfilment of His promise. In making this public declaration of

religious principle in your columns, I am well aware that by doing so I will arouse a spirit of opposition in the minds of some who will assert that your journal is devoted to the promotion of science and not religion. I would therefore shut their mouths by pointing out that we now live in very exceptional times. In my young days no journal devoted to politics and secular matters would admit into its columns religious subjects, but now all this is changed; the secular press is now full of articles bearing on religious subjects, so much so, that some have asserted "that the press has taken the place of the pulpit;" but alas, the great body of the semi-religious articles in the secular press are against true religion, and either openly or disguisedly favour superstition in one form or another. Now the main object of your journal is the promotion of the science of electricity, and one of the forms in which we see electricity is that of light. Now, concerning the origin of light, we have the clearest possible statement in the Bible: "God said 'Let there be light, and there was light'" (Gen. i., 3). Herein we have the positive information that light and consequently electricity came into existence instantaneously; they were created by the command of God. It is a distinct intimation that they did not come by the God-defying dogma of *evolution*. This is a grand subject. I hope all the electricians who read this will in the future, by their words and writings, keep unsullied this God-given foundation of the science of electricity. I now turn to the secular part of the subject, as you have given your adhesion to the main point, "*that there is only one kind of electricity*," and consequently that there is no foundation in fact for Faraday's assertion that there are two electricities or powers. I defer, for the present, noticing your remarks wherein you differ from me concerning the results of some of my experiments, as I am at present preparing to make some new experiments which I have reason to believe will throw still more light on the subject.

James Johnstone.

September 16th, 1890.

#### The Electric Light at Bath.

In your issue of September 5th, I noticed in the form of a leaderette, extracts from a letter written by Charles Powell, who I conclude imposed upon you by stating that he "recently had a run down to Bath," and that he "met the police going to the station to report lamps out and went in with them," &c. These statements are utterly untrue, as this person, instead of being the impartial looker-on that he would have you suppose, was actually in my employ at the time he professes to have visited the Bath Central Station, and working in the engine-room as driver of one of the engines, and was summarily discharged by me for savagely assaulting the second engineer, who had upbraided him for his negligence, which resulted in a breakdown and temporary extinguishment of the lights. Your contemporaries, the *Electrician* and the *Electrical Engineer*, have been imposed upon by the same person and published similar information, but, unlike yourselves, the *Electrician* had the fairness to give the name of their informant, and, had it not been for their very properly doing this, I should have been unable to expose the low cunning of this man, who when leaving here intimated to my staff that he would have his revenge for being dismissed, hence his communications to the technical press. I regret that you should have published as apparently facts, the statements of a discharged employé who appears to be as unscrupulous as he is vindictive.

H. S. Massingham.

September 16th, 1890.

[We are pleased to insert Mr. Massingham's letter, but his ideas of fairness are peculiar. It is not generally considered etiquette in journalism to give the names of those who supply information, and there was nothing to show that the news sent to us was in any way erroneous.—EDS. ELEC. REV.]

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RAILWAY ACCIDENTS FOR THE YEAR 1889.

THE Board of Trade Report on the above subject for the past year shows the total number killed in the working of railways to have been 1,076, and the number injured, 4,836. Of these 183 persons killed and 1,829 persons injured were passengers, but only 88 were killed and 1,076 injured in consequence of accidents to, or collisions between, trains. The deaths of the remaining 95 passengers, and the injuries to 813, were due to a variety of other causes, and especially to want of caution on the part of the individuals themselves.

The casualties for the year have been greatly heightened by the Armagh accident, which, it will be remembered, resulted in the death of 80 and injury to 262 children and others. Deducting this 80 killed, we have a result of 8 passengers who lost their lives from causes beyond their own control during the period, as compared with 11 for the previous year, and 25 for 1887. Making a like reduction with respect to the injured, the result is not, however, so favourable, for it leaves us with a comparison of 744 injured for 1889, as against 594 for 1888, and 538 for 1887. One is naturally inclined to make exceptions of heavy casualties such as the Armagh collision, the Tay Bridge disaster, &c., although, in point of fact, it is not quite a logical way of handling the results dealt with and considered year by year. Casting aside the exception, and looking simply at the year's result, we find that although there has been an increase of passenger journeys over those of 1888 to the extent of 2,683,909, the proportion of killed and injured to the number carried, exclusive in either case of season ticket holders, is brought down to figures very closely approximating to those of the Tay Bridge year. The result, on the whole, is not congratulatory, and we can only express a hope that future returns may not be marred by more of those heavy disasters, which cause a thrill to pass through the nation, for some years to come.

In reviewing the report, we have chiefly to deal with

those portions wherein electrical apparatus plays a part, or where, had it been in use, it might have proved of service in averting disaster.

Collisions between engines and trains following one another on the same line of rails, excepting at junctions, stations, or sidings, have, during the year, been productive of but one case, resulting in injury to 13 passengers and 1 servant. This was due to a signalman omitting to signal for permission to admit a passenger train into a section in which was standing another train at the time. A heavy fog prevailed, but that in no way authorised the signalman sending the train into the section against the electrical signals. In this case, had the outdoor signals been interlocked with the electrical signals, the probability is that the train would have been held at the stop signal, and the collision avoided.

Collisions at junctions amount to four. 88 passengers and 6 servants were injured. The most serious of these was that on the Lancashire and Yorkshire, on the 7th December; and that on the London, Chatham and Dover, on the 14th November. All of these accidents are said to be the result of want of care or judgment on the part of drivers or signalmen, and it would appear that the only way of avoiding them is to insist upon the preservation of a given space between all moving trains, or by making it obligatory upon every driver to bring his train to a dead stop before entering a junction. With the heavy traffic which now has to be dealt with at many important junctions, and the necessity of bringing forward trains for connection as readily as possible, we quite see and appreciate the difficulties which beset the question; but still, we feel that improvements are yet to be made, probably by extending the distance of distant signals, so as to give earlier intimation to drivers when they are required to stop.

Collisions within fixed signals at stations or sidings resulted in enquiries into 25 cases, in which seven passengers and one servant were killed, and 143 passengers and 20 servants injured. Nine of these were

mainly due to mistakes in block working, arising from forgetfulness or want of care, three to mistakes of pointsmen, 11 mainly to want of care of engine drivers, one to foggy weather, two to want of proper interlocking, two to want of brake power, and two to want of block working.

The want of block apparatus will, no doubt, now be supplied—if not under the recommendation of the inspecting officer, it will under the recent powers conferred upon the Board of Trade.

There were two collisions between engines and trains meeting from opposite directions, by which 24 passengers were injured. One was due to the engine driver running against the signal, and the other to the mistake of a signal porter.

The foregoing are the main points which affect, or are affected, by the electrical branch of the railway service. The time has now come when the employment of a block system, together with that of an interlocking system for points and signals is about to be enforced. In a short time all passenger lines will be thus equipped. It is not many years since pioneers were fighting for the introduction of either. Slowly the antipathies of the old school have been worn away; in many instances by arguments of so forcible a character as to no longer admit of obstruction. To the larger, more important, and more experienced companies of England and Scotland, the demands of the Board of Trade under their recent powers means, perhaps, little more than a confirmation of what they have done—as showing they were wise in, of their own will, doing that which, had they left it undone, must now have been performed under the orders of an Act of Parliament. Yet we cannot help thinking—indeed, it is not a question of doubt with us at all—that what is now being done is, although a very important part, still only a part of what has to be done to render railway working more secure. It has been our province more than once to point out that railway train working is dependent upon a double action—first, that of the electric signals, and then that of the line signals. The driver is governed by the latter. The signalman who works them is governed by the electrical signals. With but few exceptions, the one is completely dissociated from the other. The devices adopted are made as evident as possible, but still they have to be interpreted. The signalman has to obtain the electric signal, and to convey it by his mechanical signals to the engine driver.

It is quite possible to lock the one with the other. It has been done, and is in daily use. It would probably have been too great a revolution to have asked for its application to all block signals; but as there can be no question of its great advantage, it is to be somewhat regretted that an extended use of it has not been advocated, especially upon busy parts of the various systems. Doubtless the time will come for its adoption. Although originally greatly opposed, the block has now become as much a part and portion of our railway system as the rails upon which the traffic is carried. We feel that it cannot be a great while before the propriety of coupling together those two important

adjuncts which now form the controlling agent for the regulation of the traffic makes itself as apparent and as necessary to the management of the different important companies as did the earlier adoption of the block. Where this is done, we shall look for a considerable reduction in railway casualties.

#### Heating of Dynamos.

M. RECHNIEWSKI, in a paper read before the International Society of Electricians, deals with the heating of dynamos, and thinks that the "maximum temperature which can safely be admitted for the armature is about 70°, say about 40° to 50° above the temperature of the surrounding air. At this point insulating material stands well, and the effect of increased resistance of the copper is little noticeable." We are dealing with the same subject on another page, and it will be observed that, as regards the maximum temperature permissible, M. Rechniewski's views and our own practically coincide.

#### Output of Dynamos.

IN proceeding to consider the output M. Rechniewski points out that the rise of temperature due to hysteresis is similar in machines in which the armatures have the same peripheral velocity, provided all the linear dimensions are proportionally increased or diminished. He concludes that a machine having its linear dimensions increased  $n$  times, will give an output  $n^3$  times that of the smaller one if it is to attain in continuous running the same temperature. The means of eliminating Foucault currents, fully described in "A Synthetic Study of Dynamo Machines" some time since, also come in for a share of the author's attention.

#### Electric Tramways and Telephones.

THE general feeling with reference to the fight between the electric tramway and the telephone companies, as to which party is to arrange matters so that the telephone circuits are to remain undisturbed by possible leakage from the electric tramways is, that the telephone companies must give way. These companies practically claim, as first comers, the sole use of the earth, and argue that the disturbance to which their circuits are liable from strong currents should be obviated by the tramway companies insulating their lines in such a way that there should be no leakage. In a recent decision by Chancellor Gibson, with reference to a dispute in Knoxville, America, the Chancellor argued that, "If the contention that no company using a strong current, can lawfully use the earth for a return current without the telephone company's leave, be correct, then no electric company can ever use the underground on which Knoxville is built without the consent of the telephone company. It makes no difference what grand discoveries and inventions in the use of electricity may be made. Coal, wood, gas, steam and animal power may all be superseded by electrical devices, machines may be invented to heat and light all of our homes, do all of our cooking, propel all of our vehicles and machinery, and all or a large part of this electricity may be drawn from the earth, or it may be drawn from the air, and yet Knoxville and her

people are to be denied all of these wonderful benefits for all the ages to come, if they, either through the earth or through the air, in any way cripple or injure the feeble current of the telephone company, unless the telephone company gives or sells its consent."

#### The Right of Monopoly.

PROVIDED there were no means of curing the evil effects of the tramway currents, the contention of the telephone company would appear a good one, as the value of their system to the citizens may be just as great as that of an electric tramway, and, under such circumstances, the Chancellor's remarks would be hardly to the point. Again, the question may be, whether a monopoly was really granted to the company, it being unforeseen at the time that any other industry would spring up that would interfere with the existing system of telephones; if the monopoly were granted, then no matter how hardly it may press upon new comers this monopoly can hardly be repudiated without breach of contract, and though it should not be allowed to stay all further progress, it ought to be recognised by some compensation being given. The mere fact that it would cost the tramway company more than the telephone company to cure the evil is hardly a conclusive argument for forcing the telephone company to give way, though no doubt the latter is carrying out a dog-in-the-manger policy by taking up the course it is.

#### Duplication of Telephone Wires.

THE argument that all the telephone companies have to do is to duplicate their wires may appear a very plain one, and it would be so if local working only were the order of the day; but when the working has to be over trunk lines on to other systems, it either means duplicating the trunk lines and the circuits of the other systems also, or else working with induction coil repeaters at the ends of the trunk, which is not conducive to good speaking.

#### The Post Office and Electrical Disturbances.

AS regards electric light circuits, considerable trouble, we believe, has been experienced by the Postal Authorities from the action of the Ferranti mains of the London Electric Supply Corporation. In the event of this disturbance not being cured by the Corporation, is it to call upon the Department to duplicate their wires?

#### The Efficiency of Arc Lamps.

WE should have thought the time had gone by for electrical journals to describe any particular arc lamp as giving more light per horse-power than another. Yet we find an esteemed American contemporary seriously assuring its readers that, with respect to one design of lamp, such is said to be the case. As a matter of fact, for the same current and difference of potentials there is produced with similar carbons the same amount of light; and while makers may endeavour to delude the public in the manner referred to, technical journals ought to be careful that they do not appear to lend themselves to the deception. Regarding the makers, we never knew one yet who did not claim that his lamp, as compared with others, took least power and gave the steadiest light.

#### Mitis Metal for Field Magnets.

PROFESSOR SILVANUS THOMPSON'S Cantor lectures on "The Electro-magnet" teem with practical hints. Speaking of Mitis metal, which is a kind of cast wrought iron rendered fluid by the addition of a small percentage of aluminium, Dr. Thompson states that he has found this metal far superior to ordinary cast iron, and not much inferior to wrought iron. It is well known that the field magnets of dynamos and motors are made to certain forms, mainly to avoid expensive forgings on the one hand, or inferior results with cast iron on the other. In most cases a compromise is made by using good wrought iron for the straight cores, and cast iron for the pole pieces, the latter involving difficult work if forged out of wrought iron. Mitis metal it appears, if easily produced, would bring about material deviations from existing types of field magnets, especially for the cheaper class of dynamos and motors. Indeed, a reasonably small difference in permeability may be compensated for by some advantageous design which could not hitherto be adopted in the case of wrought iron, owing to structural difficulties. Further research in this direction might lead to important results from a commercial point of view.

#### Electric Traction.

IT is anticipated that Electric Traction will form an important topic of discussion during the forthcoming meetings of the several American Street Railway Associations. Until three years ago these societies not only occupied themselves exclusively with matters concerning horses, stables, manure and horse cars, but when the subject of electric haulage was mooted the introducers of the novel "fad" were looked upon with suspicion and scepticism. Times have changed with astonishing rapidity. Many of the advocates of the horse have been converted to modern ideas, others have dropped avowed opposition and are now watching events. None can upset the remarkable fact that out of 8,652 miles of tramways in the United States, 1,753 miles, or nearly 20 per cent., are now worked with electric cars. We expect, therefore, to hear of many practical results from practical men who view the present situation entirely from the financial point of view: thus we may contrast the utterances of the old-fashioned tramway man with those of the modern electrical engineer, and draw useful conclusions.

#### Fatal Electric Tram Accident.

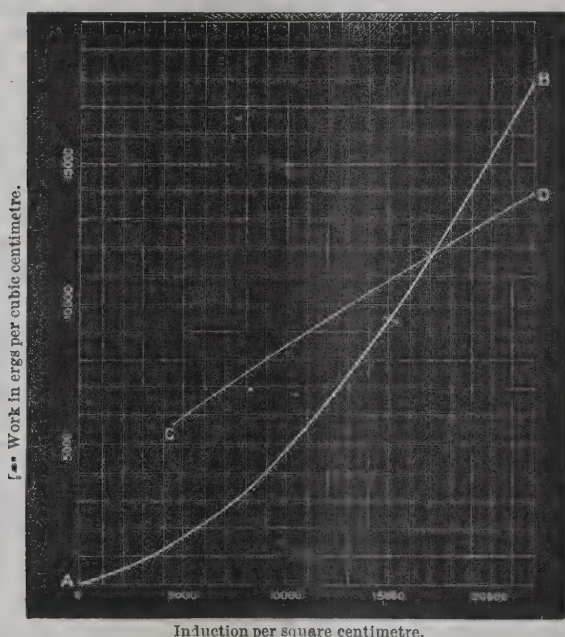
A TELEGRAM from Florence under the date of September 23rd, announces that a fatal accident occurred on the electric tramway between that city and Fiesole. The cars ran off the track, five persons being killed on the spot and 20 others injured. On being informed of the occurrence, the King and Queen and the Prince of Naples at once gave up the idea of attending the races, as had been their intention, and visited the injured. Such a fatality reflects seriously upon the tramway authorities, and there must have been either inefficient driving, badly constructed permanent way, or failure of brakes, in all of which cases the blame will be attached to the electric system by the timid public. This is all the more to be regretted since electric traction has been in a fair way of gaining public favour in Italy.

A SYNTHETIC STUDY OF DYNAMO  
MACHINES.

(Continued from page 207.)

IX.—THE HEATING OF MACHINES (*continued*).

As stated in our last article, the temperature attained by the best class of machines, when working in the normal atmosphere for which they are designed, seldom exceeds 75° C. On land it is generally under this, and the rise of temperature allowed from the start is most frequently from 30° to 40° C., which is, of course, included in the 75° C. mentioned above, or whatever may be the maximum attained. The evil of overheating is not perceived at once, or it may be for a long time after a machine has been set to work. The deterioration of the insulating material is gradual, and consists in its eventually "perishing" or becoming "rotten" with the continuous heatings to which it is subjected. When this condition is reached, it has lost all its original tenacity and toughness, and has become extremely brittle. The paper, calico or fibre has become of a dark colour, and the cotton covering of the wire has a semi-charred appearance. Although the insulation resistance may be as high or higher, in fact, than it was originally, the armature is more liable to break down when in this state. It is, therefore, of the greatest importance to prevent overheating, if it is desired to combine long life with high efficiency.



Induction per square centimetre.

FIG. 150.

We have said that there are three sources of waste—first, the energy spent in the conductors due to their having some resistance; secondly, the energy expended in continually changing the direction of the magnetism in the rotating core; and, thirdly, the energy of feeble parasitic currents generated in both conductors and core. The energy dissipated in the armature due to the first cause can be calculated from the resistance of the winding from brush to brush and the total current flowing. The loss from the third cause cannot be very readily calculated, but may be rendered almost negligible by adopting the precautions insisted on in Section VII., dealing with parasitic currents. The points necessary to be observed in construction, so that these might be eliminated as much as possible, were then clearly stated; briefly, the core has to be supported so that no part of the supports is subject to inductive action, the core has to be laminated in planes perpendicular to the direction of induction, and parallel to the direction of motion, and the conductors have to be divided and grouped in certain ways in the winding. If these rules are carefully attended to, the loss due to parasitic currents be-

comes unimportant; not so, however, is the second source of loss, which we are about to consider.

In carrying a piece of iron through a cycle of magnetisation, there is expended in the operation a definite amount of energy depending on the induction and on the character of the iron. Starting with a piece of iron magnetised in one direction, a cycle defines the operation by which the induction is reduced to zero, reversed and brought up to the same strength in the opposite direction, again reduced to zero, and finally brought up to its first degree of induction. Imagining for a moment that every molecule of iron is a small magnet, it will be readily perceived that, since the axial direction of the molecules is governed by the direction of induction, in one complete cycle each molecule must rotate once with reference to the mass of which it forms a unit. In producing this rotation involved by the magnetic cycle, work is performed either in overcoming a kind of frictional resistance, as has been hitherto assumed, or in overcoming the magnetic forces which the molecular magnets exert upon each other, as has been suggested recently by Prof. Ewing. The energy expended in carrying annealed soft iron wire through cycles such as described, has been carefully determined by this experimenter, a curve showing the results being given in fig. 150. The induction per square centimetre is plotted as abscissæ, and the energy in ergs required to carry a cubic centimetre of soft iron through a complete cycle at different inductions is measured by ordinates. The resulting curve, A, B, shows that the energy increases at a somewhat greater rate than the induction. The use of the curve, C, D, will be seen hereafter.

In applying these results to the case of a revolving armature core, it has been assumed that, in causing the molecules to rotate, there is performed the same amount of work as given above, although in the former case the molecular rotation is caused by varying the intensity of magnetisation, carrying it through zero and reversing its direction, while, in the case of the armature, it is produced by change in direction without change in intensity. The assumption seems a fair one, though it must be remembered that the energy required is reduced somewhat in the presence of vibration, and that consequently the work, in a moving armature core, might be expected to be under the amount here given. Again, Ewing's experiments were performed by making the changes very slowly, and, in dealing with armatures, the farther assumption has to be made that the work done per cycle is the same, whether the changes are slow or rapid. Some idea of the power wasted in reversing the magnetism of the armature may now be obtained. Taking a direct current two-pole 300-light machine having a ring core, say, of 33 centimetres diameter, with an internal opening of 23 centimetres and a length of 28 centimetres, the same amount of soft iron contained in such a core is, allowing for insulation between the plates, 11,000 cubic centimetres. The induction is, say, 17,000, and from the curve we get the ergs expended per cycle per cubic centimetre as 11,800. The speed of the armature being

900 revolutions per minute, this gives us  $11,000 \times \frac{900}{60}$

$\times 11,800$  ergs per second = 195 watts. There would probably be expended in heating the armature coils of such a machine 780 watts, the heat generated in magnetising and demagnetising the iron core constituting, therefore, about 20 per cent. of the total heat generated in the armature. In alternating current machines, where the number of cycles per second is rather more than six times as many, it will be seen that the work expended on changing the direction of the magnetism becomes of great importance relatively to the other sources of waste.

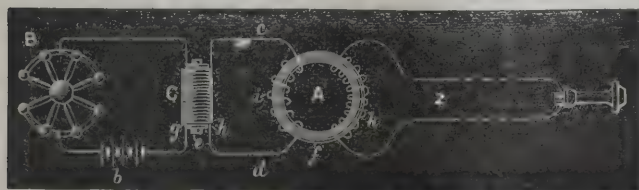
In this article, we have seen that the amount of heat generated in the armature can be calculated with a fair degree of accuracy. In our next article, we have to determine the amount of cooling surface it is necessary to allow in order that the heat generated may be got rid of without exceeding the specified limit of temperature.

(To be continued.)

## TELEPHONE INDUCTION COILS.

In a recent number of the *Electrical Engineer* (New York), a system of telephony devised by Mr. T. D. Lockwood is described. The employment of closed circuit induction coils in telephony involves certain considerations which do not appear at first sight. It is, of course, comparatively easy to operate electric light transformers by means of reversals of the primary current, because, since the secondary currents to be evolved need have no special form, character, or quality, these reversals may readily be produced by using an alternating dynamo as a source and by sending its currents unrectified through the primary helix. But no such procedure is possible in telephony, for the voice currents developed in the secondary circuit of the induction coil, which are to traverse the line and reproduce speech at the distant station, must, so to speak, be an electrical copy of the variations of the sound waves initiating them, and also of the sound waves they are to reproduce. Up to the present time, however, it has not been found practicable to produce reversals in the primary circuit of transmitting telephone induction coils, and in all such instruments which have gone into use the change which the operation of the transmitter effects in the primary circuit is not a reversal of current, and hence cannot result in a reversal of magnetism with its inherently-consequent zero moment. It is not even a succession of absolute cessations and emissions of current, as in the make and break of the Ruhmkorff induction coils. The change which is effected by such operation is the variation of current strength, tending to produce a variation of magnetic intensity in the core, which, if produced, results in corresponding magneto-electric currents in the secondary helix and line; but the magnetism of an iron ring core once magnetised does not greatly vary when simple changes only are made in the strength of the magnetising current. Thus, while it tends to advantage to employ induction coils having closed magnetic circuit cores, such a procedure demands also a practical method of producing reversals in the primary circuit of the induction coil, and it is to accomplish the latter object that Mr. Lockwood has designed the system we are about to describe.

The method employed is illustrated diagrammatically in the fig. Here B is a multiple-contact microphone, which is placed in the circuit of a battery, *b*, in which also is serially included the primary conductor, *g*, of the induction coil, C. This circuit may be termed the "local circuit." The secondary conductor, *h*, of this coil has the same number of convolutions, and is of the same size wire, and both are, as usual, wound upon a cylindrical core, *e*, of iron wires.



The induction coil, A, has a continuous core, *f*, of soft iron, and constituting a closed magnetic circuit. This has a primary conductor, *i*, the same size and length as that employed in the two helices of the first coil, which is joined up in circuit with the secondary conductor, *h*, of induction coil, C, and the closed circuit so constituted may be termed the "intermediate circuit." Thus alternating currents generated in conductor, *h*, inductively by changes of current in conductor, *g*, will be of like character with such changes, and will of necessity circulate in and through the primary conductor, *i*, of induction coil, A. The resistance of the conductors, *g* and *h* and *i*, is low, being but a fraction of an ohm.

The secondary conductor, *k*, of coil A, is of fine wire, for the purpose of securing a great many convolutions, it being required not only to transfer electrical energy from the reversals circulating in *i* to the secondary con-

ductor, *k*, but to raise the potential. The secondary, *k*, of the induction coil, A, is connected with the wires of the main telephone circuit, Z, leading to the distant station and telephone receiver. In actual practice Mr. Lockwood winds the primary coil in alternate sections, spaces being left between each for similar sections of the secondary winding. The advantage of this method of winding is that the magnetisation is thereby distributed uniformly, and is enabled to act equally upon all parts of the core.

It will be observed that the function of the first induction coil is to develop alternating currents in the intermediate circuit without raising the potential of such currents. If the potential in this circuit were to be raised, it would be necessary to multiply the convolutions of both the helices included in it, with a consequent increase in cost, in resistance, and in waste of energy. Furthermore, it is of great importance to keep down the resistance of this intermediate circuit, for the reason that in telephony self-induction is a potent factor in opposing the proper operation of the current, and the self-induction of any circuit of which coils or helices form a part is mainly dependent upon the number of their convolutions. Hence, there is special utility in employing a few convolutions of thick wire instead of a greater number of convolutions of thinner wire in the intermediate circuit.

We witnessed some experiments a few years ago with coils constructed like transformers, to be used for translation purposes from a single wire to a double wire system, but the *speaking* results were extremely poor, though the ringing of the call bells (on the magneto principle) was all that could be desired. On the other hand, it was found that when ordinary induction coils were used as translators, the speaking was excellent, but the magneto bells would not ring. Mr. Lockwood's method seems well adapted to make both speaking and ringing good, but the use of two induction coils would appear likely to involve a loss of power, and it seems open to doubt whether any directly beneficial result is practically found to result from the new arrangement. We observe that the *Electrical Engineer* is silent with reference to the practical working of this method.

BRITISH ASSOCIATION FOR THE ADVANCE-  
MENT OF SCIENCE.—LEEDS, 1890.

## ON THE SPECIFIC RESISTANCE OF COPPER.

By T. C. FITZPATRICK.

(Read in Section A, September 9th, 1890, in conjunction with the report of the Committee on Electrical Standards.)

ALL the values given in tables for the specific resistance of the metals are directly or indirectly obtained from the values given by Matthiessen in his series of papers published in the "Transactions of the Royal Society" for the years 1860—1864, and in the reports of the British Association for the same years.

In the "Transactions" for the year 1860 is a paper by Matthiessen on the conductivity of pure copper and on the effects of impurities. No alloy of copper has as high a conductivity as the pure metal. His results are expressed in terms of the conductivity of a hard-drawn silver wire (100 at 0°). He gives the following values for samples of copper carefully prepared by himself:—

(1)	93.00	at 18.6°	} Giving a mean value of 93.08 at 18.9° as the conductivity of pure copper.
(2)	93.46	" 20.2°	
(3)	93.02	" 18.4°	
(4)	92.76	" 19.3°	
(5)	92.99	" 17.5°	

Numbers are given showing the effect on the conductivity of small quantities of oxide, and he states that he found it necessary to pass hydrogen through the molten metal for some time for entire reduction. In the "Transactions" for 1862 Dr. Matthiessen has a paper on the influence of temperature on the conductivity of metals. He again expresses his results in terms of a hard-drawn silver wire.

On page 8 will be found the results of his experiments on copper: the lowest temperature at which measurements were made was 12° or 16°; he there shows how the results for pure copper measured at 18° may be reduced to 0° C.; but no measurement was actually made at 0° for any of the metals experimented with.

\* "Phil. Trans.," 1860, p. 85.

He expresses the influence of temperature on a hard-drawn copper wire; the mean result of a number of determinations by the equation

$$\lambda = 100 - .38701 t + .0009009 t^2$$

where 100 is the conductivity of copper at 0° C., so that a hard-drawn silver and copper wire have the same conductivity at 0° C.

The values obtained by comparison with a hard-drawn silver wire are then largely the source of the tables of specific resistances; but at the end of his appendix to the report of the Electrical Standards Committee for 1864, Matthiessen gives values for hard-drawn silver and copper wires in terms of the new B.A. unit; expressed as the resistance of a wire one metre long, weighing one gramme.

These values are:—

Copper	...	...	.1469
Silver	...	...	.1682

The same table of values is given in the *Philosophical Magazine* for 1865, where also is given a table of specific resistances for wires 1 metre long and 1 millimetre diameter expressed in terms of the B.A. units, calculated from the value of the known conducting power of the gold-silver alloy in terms of hard-drawn silver, and also in terms of the B.A. unit.

The values thus obtained do not agree at all well with the results calculated for the resistances of the gramme metre by the specific gravities of the elements furnished by tables.

Thus—

Silver	...	...	.02048	...	.02603
Copper	...	...	.02090	...	.02104

He states that he omitted to determine the specific gravity of the copper used in his experiments; he probably would not have obtained any very adequate results, and the weight of copper he used varied from 1.5 to 4 grammes.

The accuracy of Matthiessen's results seems to depend, therefore, on the accuracy of his determination of the resistance in terms of the B.A. unit of a hard-drawn silver wire; in considering, therefore, the question of the preparation of samples of copper of higher conductivities than Matthiessen obtained, it may be suggested that the cause of the difference is not explained by the fact that Matthiessen did not prepare pure copper, but by the error in the value of the standard with which the comparison was made.

I have, therefore, made a series of experiments on the resistance of pure silver wires; and, as a general result, have obtained a value identical with that of Matthiessen; the difference is not due, therefore, to an error in the standard employed, as far as my experiments go.

Matthiessen does not give anywhere the details of his measurements of the specific resistances of the metals in terms of the B.A. unit; in the B.A. report he simply mentions that an approximate table is subjoined, not even stating the fact that the values are for a temperature of 0° C. I conclude, therefore, that these values are calculated out from the former, of which an account is given in the same B.A. report, and which were performed at a temperature of 20° C.

I have, therefore, on this account, as well as for other reasons stated later, made my measurements at the temperature of the air, and believe that as his values were reduced by a temperature coefficient to values at 0° C.; I shall, by using the same temperature coefficient, and raising his value to near that for 20° C., obtain results directly comparable with Matthiessen's direct measurements.

For the measurement of the resistance of the specimens of wire a Wheatstone's bridge arrangement was employed, two of the arms of the bridge were formed by a 10 and 1 standard B.A. unit, namely (66 and g); these were so nearly 10 to 1, that they were taken to be in that ratio.

The third arm was one-third of a B.A. unit, and in the fourth arm was the wire to be measured, this was stretched on a flat board, and soldered at the ends to copper plates, to which connecting wires were also soldered; the length of wire used was generally a little less than two metres, and the wires were, approximately, No. 18 B.W.G. The board had scales screwed to it at the two ends; the board and wire were placed in a long bath made of zinc, and filled with paraffin; wires which were left in the bath for some days, and, in more than one case, several weeks, were not found to have been at all acted on by the oil.

One end of the wire, P<sub>2</sub>, Q<sub>2</sub>, was connected by a binding screw through an adjustable resistance, r, (½ metre of copper wire) to the mercury cup, Q<sub>1</sub>, in which was one of the legs of the one-third coil, and also to a reversing key in the battery circuit.

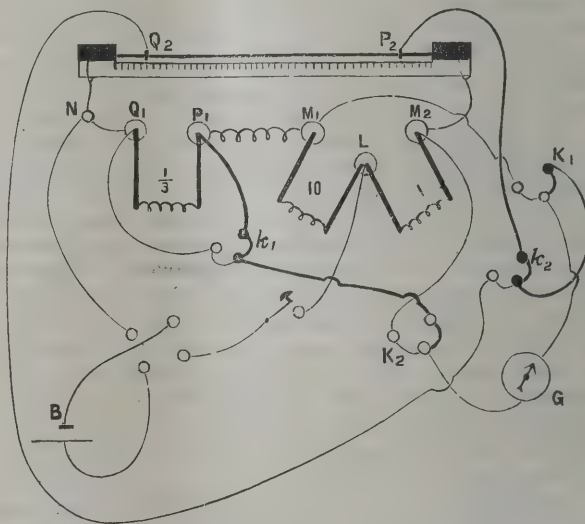
The ⅓rd and the 10 were connected up together through an adjustable resistance, P<sub>1</sub>, M<sub>1</sub>, one leg of each of the coils 10 and 1 were in the same mercury cup, L; and the other end of the 1 B.A. unit was connected with the other end of the wire, P<sub>3</sub>, Q<sub>3</sub>.

A single Leclanché cell was connected up with the reversing key and the fourth point of this key was connected with the mercury cup, L, into which the legs of 10 and 1 dipped. In this circuit there was also a touch key. The galvanometer circuit was always made, and thus there was no thermo-electric effect on meeting the galvanometer circuit. To each of the mercury cups, Q<sub>1</sub>, P<sub>1</sub>, M<sub>1</sub>, M<sub>2</sub>, were connected with separate binding screws two thick wires, one of which was welded to the copper plate at the bottom of the mercury cup. Each of these latter wires were connected with two way-keys; those in P<sub>1</sub> and Q<sub>1</sub>, to the key, k<sub>1</sub>; those in M<sub>1</sub> to the key, K<sub>1</sub>; those in M<sub>2</sub> to the key, K<sub>2</sub>.

The base points of the keys, K<sub>1</sub> and K<sub>2</sub>, were connected with a delicate reflecting galvanometer, that employed for the com-

parison of the standards on the Fleming bridge. The base of the key, k<sub>1</sub>, was connected with the third point on the key K<sub>2</sub>, and the third point, on the key, K<sub>1</sub>, was connected to the base point of a fourth key, k<sub>2</sub>, the two other points on this key being connected with riders, with which contact can be made with two points on the wire, P<sub>2</sub>, Q<sub>2</sub>; the riders had straight edges, and thus their positions on the scales could be easily determined. In performing an experiment, the keys, K<sub>1</sub> and K<sub>2</sub>, were so connected that the mercury cups, and so the ends of the coils, 10 and 1, were in circuit with the galvanometer. The resistance, R, P<sub>1</sub>, M<sub>1</sub>, was then varied till, on making the battery circuit, no deflection resulted. The ends of the 10 and 1 were then at the same potential, and as the other ends of these coils were connected with the same pole of the battery, there was the same fall of potential on the two lines.

The keys, K<sub>1</sub> and K<sub>2</sub>, were then reversed, and by the keys, k<sub>1</sub> and k<sub>2</sub>, one end of ⅓rd coil and one point on the wire, P<sub>2</sub>, Q<sub>2</sub>, were connected through the galvanometer, and afterwards the two other ends. The riders were adjusted till there was no deflection of the galvanometer. The length of wire between the two riders had a resistance of ⅓th that of the ⅓rd B.A. unit coil.



By means of the series of keys it was easy to repeat the observations and to connect the ends of ⅓rd coil with the wire. The resistance, R, did not often change during the experiments, as the room was at a constant temperature, any change in R only caused a shifting of the position of the riders. In each experiment, after all the adjustments, the bath was well stirred and everything left for half-an-hour. It was generally found that the riders did not require any adjustment. The battery was reversed and all the coils moved. The latter never caused any effect; sometimes the reversal of the battery caused a shifting of the two riders a millimetre or two in the same direction.

Another reading was taken three or four hours after. The coils ⅓rd, 10, and 1, were in water baths, and their temperature remained the same for hours together. The temperature of the paraffin bath, of course, was not so constant, it was kept well stirred in, and a thermometer reading to .2° C. never showed any difference in the temperature at the different ends of the bath when the readings were taken. The thermometer employed was Kew corrected; and the corrections given were verified by recent comparison with a platinum thermometer by Mr. Griffiths.

Since the two standard coils employed were accurately in the ratio of 10 to 1, the accuracy of the resistance measurement depended entirely on the value of the ⅓ B.A. unit. This was first made as nearly as possible ⅓, but it was found that for the size of the wires measured (18 B.W.G.) this was too high a resistance, it had, therefore, to be reduced. For the determination of its value there was cut out in a block of paraffin wax a large central mercury cup and outside this a circular channel; thick copper plates were cut to fit them, and both were well amalgamated. By means of this cup arrangement the three B.A. units (H, G, and flat) were connected up in multiple arc, and by means of stout copper rods the multiple arc arrangement was connected with the mercury cups with the Fleming's bridge, and so compared with the ⅓ B.A. unit, the temperature of the ⅓ being given. The following observations were taken:—

July 12th, 1889:—1/3, (18.4°) + 986.6 (b.w.d.) = M.A. + 24.6 (b.w.d.)

July 22nd, 1889:—1/3, (17.4°) + 986 (b.w.d.) = B.A. + 24.1 (b.w.d.)

Aug. 26th, 1890:—1/3, (16.8°) + 986.1 (b.w.d.) = M.A. + 23.9 (b.w.d.)

The value of a bridge wire division (b.w.d.) is .0000498 B.A. units at 15°, and the wire has a temperature coefficient of .00143. It is evident from these series of values that the ⅓ has not changed in resistance during the period of the experiments.

This comparison, however, introduced a possible error as the temperature of the bridge wire at the time of experiment was not accurately known, and this is important when nearly the whole of the bridge wire is employed. To eliminate this possible error the ⅓ was compared with four B.A. units in multiple arc. In this

case a large number of bridge wire divisions had to be subtracted from the value of the 1/3, and the whole number of bridge wire divisions entering into the calculation for the values of the 1/3 was largely reduced. The four coils in multiple arc were (F, G, H, and flat) :—

Aug. 25th, 1890 :—1/3, 16·8° + 157 (b.w.d.) = M.A. + 852·05 (b.w.d.)  
Aug. 26th, 1890 :—1/3, 16·8° + 157·5 (b.w.d.) = B.A. + 851·9 (b.w.d.)

All the four coils were at the same temperature (16·8). These values are taken from the B.A. Report, 1888.

Flat	...	...	...	1·000448
F.	...	...	...	1·000028
G.	...	...	...	·99955
H.	...	...	...	·99969

These give for the two multiple arc arrangements the values ·33330 and ·24998. The connecting rods had a resistance of ·00042, and these gave for the value of the 1/3 at 16·8° ·28537. The temperature coefficient for the coil is ·0001 per 1° C.

To measure the lengths of the wires two microscopes with scales and verniers reading to ·1 of a millimetre were set up and firmly clamped in position; the distance between them was determined by means of the beam compass and the aid of a third microscope; the distance between this and the other two being directly read off on the beam compass for set positions of the verniers. The wires were cut with a fine fret saw at the points corresponding to the position of the riders in the resistance measurements. Before weighing the wires were carefully cleaned with methylated spirits, the balance employed was the one used by Mr. Glazebrook for our determination of the specific resistance of mercury, the weights were balanced against one another, and in all cases double weighings were taken.

The specific gravity of most of the wires was measured, for this purpose distilled water was boiled and cooled rapidly, the coil of wire immersed and the beaker and its contents placed under the receiver of an air pump, which was connected up with a water pump, this was left running for two or three hours till all air bubbles had disappeared, the weight of the wire in water was determined, and a second reading taken some hours later; as the weight of wire used was from 16 to 20 grammes, fairly accurate values for the specific gravity of the several wires ought to have been obtained, and thus the value for each wire in terms of the B.A. unit for the resistance to conduction between the opposite faces of a cube of the material was found.

Resistance of Various Specimens of Wire.

Wire.	Date.	Resistance of a wire such that 1 metre weighs 1 gramme at 18° C.		Specific gravity.	Specific resistance per cc. at 18° C.	
		Hard drawn	Annealed.		Hard drawn	Annealed
I.	July 22, '89	...	1549	8·86	...	1743
	Nov. 6, '89	...	1550	8·87	...	1745
II.	July 22, '89	...	1545	8·88	...	1741
	Dec. 2, '89	...	1546	8·89	...	1742
III.	Dec. 3, '89	...	1713	8·87	...	1922
IV.	July 10, '89	1578	...	8·89	1776	...
	Aug. 1, '89	1578	...	8·89	1776	...
IV <sup>1</sup> .	Nov. 1, '89	...	1511	8·885	...	1724
V.	July 31, '89	1573	...	8·89	1770	...
	Oct. 30, '89	1572	...	8·89	1770	...
V <sup>1</sup> .	July 20, '89	...	1526	8·89	...	1712
	Aug. 2, '89	...	1526	8·89	...	1713
	Aug. 8, '89	...	1527	8·89	...	1716
VI.	Aug. 10, '89	1546	...	8·94	1730	...
	Oct. 18, '89	1549	...	8·94	1732	...
	July 10, '90	1549	...	8·94	1731	...
	July 14, '90	1548	...	not observed	...	...
VII.	Aug. 8, '89	...	1508	8·94	...	1688
	Oct. 11, '89	...	1509	8·94	...	1688
VIII.	Nov. 4, '89	1543	...	8·946	1724	...
	July 15, '90	1543	...	...	...	...
IX.	Oct. 23, '89	1700	...	8·95	1903	...
	Oct. 28, '89	1702	...	...	...	...
X.	Aug. 5, '90	1572	...	8·90	1766	...
	Aug. 18, '90	1572	...	8·90	1766	...
XI.	Aug. 5, '90	1573	...	8·91	1767	...
	Aug. 26, '90	1569	...	8·92	1751	...
Matthiessen's value reduced to 18°, using his own coefficient	Aug. 27, '90	1569	...	8·93	1750	...
		1571	...	not given	1766·6	As calculated by Fleming, Jenkin & Fitzpatrick

The first object of these experiments was to test directly in comparison with the B.A. standards samples of copper wire of high conductivities, with the view of comparing them with Matthiessen's standard. Application was therefore made to several firms for high conductivity copper wires, for which my thanks are due to those who sent samples.

A table of results is subjoined, the results for all the specimens tested are given, and they show the variation in resistance of high conductivity wires.

IV. and IV<sup>1</sup>. are the same copper, but IV. is hard drawn, IV<sup>1</sup>. is annealed; they were measured just as they were sent from the manufacturers; the same is true of V. and V<sup>1</sup>, VI. and VI<sup>1</sup>.

It will be noticed that VI. and VI<sup>1</sup>, which are of considerably less resistance than the other wires, are of higher specific gravity; the firm that sent them thus wrote of them, "it is only occasionally we come across copper as high as this or high enough to be called the highest (in conductivity) we can produce. This copper has been produced electrolytically by our ordinary process." How this copper was treated after electro-deposition I do not know, I am inclined to think from my own experience that this difference in density is due rather to the condition of the copper, than to its relative purity. Matthiessen found that very small quantities of impurities reduced the conductivity 20 or 30 per cent. and a sufficient amount of impurities to cause this decrease in density from 8·94 to 8·90, must make a larger increase in the resistance of the copper.

The temperature coefficient is stated to be different for various specimens of metal, according to their purity; Matthiessen himself seems to have been of this opinion, but the mere difference in density of the metal might be expected to effect the alteration of conductivity with the same change in temperature.

I have not been able to find any experiments bearing on this question. It is quite easy to obtain samples of wire of different density by varying the process of drawing, and the temperature coefficients of such wires might be found to be different.

Comparing V. and V<sup>1</sup> with VI. and VI<sup>1</sup>. it is seen that with this increase of density there is a distinct diminution in the effect of annealing.

$$\begin{aligned} \text{IV.} - \text{IV}^1 &= \cdot00677 \\ \text{V.} - \text{V}^1 &= \cdot00577 \\ \text{VI.} - \text{VI}^1 &= \cdot004 \end{aligned}$$

I thought it might be possible that VI<sup>1</sup> was not completely annealed, so, for a direct comparison, two specimens of VI<sup>1</sup>, which had been measured hard drawn on July 10th and 14th, 1890, were annealed; for this purpose a flat copper vessel was made of about 2 cm. height and 18 in diameter, with a closely fitting lid; the wire was packed in this between sheet asbestos, which had been previously heated up; the vessel was filled up with lampblack, the vessel was heated over a big bunsen burner and gradually cooled, the process generally took about 24 hours, the wire was found not to be oxidised at all after the process was over.

Wire.	Hard-drawn	Annealed.	Difference.
I.	1549	1510	·0039
II.	1548	1509	·0039

The difference Matthiessen obtained was ·0038.

The above method of annealing was found very effective. Silver wires, which on annealing decrease 10 per cent. in resistance, gave the same value in a second annealing as they did on the first occasion.

Wire VII. was a wire sent me by Mr. H. A. Taylor, and had to be drawn down before it could be measured; another piece of the same wire drawn down on a different occasion, gave the same value; this wire has the lowest resistance of any I have obtained; it has, too, the highest specific gravity; Mr. Taylor says of it, "That it has a higher temperature coefficient than that given by Matthiessen."

VIII. was a sample of wire obtained from Germany, and said to be electrolytically prepared; its high resistance is, I think, due to the presence of oxide, and I fused some of it up in hydrogen, and when measured partially annealed it gave the value ·1566 at 18° for the wire 1 metre weighing one gramme.

IX., X. and XI. are wires of my own preparation. Pure copper was prepared electrolytically by Messrs. Sutton, of Norwich, and supplied me in thin sheet, and this was fused down in porcelain tubes of 18 centimetres in length and 1 centimetre in diameter; the tube was fitted up in a small furnace made of sheet iron and lined with ganister; this was heated readily by a blast flame led in at the bottom; some difficulty was experienced in obtaining the copper in a solid cylinder; in the early experiments hydrogen was passed into the tube whilst the copper was being fused and was made to bubble through the molten copper; on breaking the tube, the copper was found to be full of small holes; the copper had absorbed the hydrogen at the high temperature and given it off again on cooling; on another occasion the copper was fused down in hydrogen and the tube was connected with a water pump and exhausted, and the copper allowed to cool in a vacuum; this gave a more continuous cylinder. It was found best to fuse the copper under borax, it having been previously reduced; a good cylinder of the metal was thus obtained.

I was unfortunately not able to draw down the copper for myself; this was very kindly done for me by Messrs. Smith, of Halifax, and Messrs. Johnson and Matthey. The porcelain tubes had been prepared of such a size that the cylinder of copper could be drawn without further heating; the copper, therefore, was not fused after it left my hands.

Two sheets of the electrolytically prepared copper were used

down on different days, and one was sent to Messrs. Smith to be drawn, and the other to Messrs. Johnson and Matthéy.

Wires IX. were drawn by Messrs. Smith, wires X. by Messrs. Johnson and Matthéy.

Wire XI. was drawn by Messrs. Johnson and Matthéy from a sample of copper which I prepared by electrolysis, from a pure solution of copper sulphate; the copper was deposited on a plate of copper, which had had its surface rubbed over with graphite; by this means the deposited copper was easily stripped off the plate, the other plate was of platinum, after a time the solution was changed; the deposition was very slow, as it was thought that there would be less likelihood of copper sulphate getting in between the layers of copper.

The deposit was boiled with dilute sulphuric acid and then in water, and was afterwards fused down as above described.

Wires IX. were measured as received, this accounts for the close agreement between the two determinations. Wires X. and XI. I had to draw down further to measure them on my bridge.

Wires X. (2.) and XI. were drawn down with great care and not so much as X. (1.)

Below is a table of the measurements made for the determination of their specific resistances.

Wire.	Value of $\frac{1}{s}$ .	Temp	Weight of wire.	Length of wire for determination of resistance.	Length cut and weighed.	Resistance of gramme per metre.	
IX. (1.)	·28547	17·9°	20·388	192·1	192·5	1574	18·3°
„ (2.)	·28541	17·4°	20·153	192·4	190·45	1569	17·5°
X. (1.)	·28550	18·2°	19·708	189·3	188·8	1577	18·6°
„ (2.)	·28536	16·8°	20·252	192·39	192·34	1561	17·1°
XI.	·28535	16·7°	20·262	192·11	192·51	1563	17·2°

These values reduced to a common temperature of 18° are:—

IX. (1)	...	·1572	
IX. (2)	...	·1572	Mean value
X. (1)	...	·1573	·1571
X. (2)	...	·1569	B.A. units.
XI.	....	·1569	

Thus ·1571 B.A. units is the resistance of a metre of hard-drawn copper wire at 18° weighing 1 gramme.

Matthiessen in the B.A. Report\* gives as the resistance of a gramme metre at 0° ·1469 B.A. units.

I have calculated from this the value at 18°, using the temperature coefficient that he gives in his paper on the influence of temperature on the conducting power of metals. I have taken no account of the terms in  $t^2$  as they practically cancel one another.

$$R. \text{ (at } 18^\circ) = R_0. (1 + \cdot0038701 t)$$

$$R. 18^\circ = \cdot1571.$$

This is the same value that I have obtained as the mean of my own observations.

All my observations were taken at the temperature of the room, and in the table above, the values for the different wires are given at the observed temperature, and then all reduced to a common temperature of 18° C. Most observations of this character are taken at the temperature of 0° C., but on the whole it seemed more satisfactory to work at the temperature of the room. In the comparison of the B.A. units I have found that with a difference of temperature between coils which are connected by thick pieces of copper there is always conduction of heat, and it is impossible to tell accurately what is the real temperature of the coils.

My observations were made in the B.A. room at the Cavendish Laboratory, which has a north aspect, and often the temperature does not alter more than a few tenths of a degree, whilst the temperature of the coil baths often remains perfectly steady for several consecutive days. I cannot find any observations of Matthiessen's at 0° C; certainly his observations on copper were made at 18°, and, consequently, if the value given by him at 0° C. has been obtained by the use of a temperature coefficient, my value might be expected to agree with his at 18°, the temperature of his observation, supposing the samples of copper of the same character.

Matthiessen's results are given in terms of a gramme per metre, also for wires of metre length and 1 mm. in diameter.

In a paper in the *Philosophical Magazine*, Matthiessen gives us the value for hard-drawn copper in these terms as,

$$\cdot02104 \text{ B.A.}$$

From his value for the Gramme metre, using the sp. gravity 8·95 given by tables, the same quantity was calculated but gave the result ·0209; in a note added, he states that had he used the sp. gravity 8·91, his results would have been more nearly alike; but a sp. gravity 8·90, I find, would give an almost identical value.

This would show then that Matthiessen's own table calculated for values obtained by comparison with hard-drawn silver is accurate; I have tested silver wires, but have not had time to

draw up the results in tabular form; and I obtained an almost identical value for hard-drawn silver wire, as supplied me from Messrs. Johnson and Matthéy, as is given by Matthiessen for the resistance of a gramme per metre.

It will be observed that wires IX. have the specific gravity 8·90, and give a value in terms of B.A. units for a cubic centimetre of the material identical with Matthiessen's value; this value is not given directly by Matthiessen, but is calculated from his results by Fleming Jenkin and given in his table in his book "Electricity and Magnetism," it is 1,652. I have calculated it from Matthiessen's value given in the *Philosophical Magazine*, and get the number 1,653. Using the same temperature coefficient as before, the resistance of a cubic centimetre of hard-drawn copper is 1766·6.

On comparing the values for wires IX., X. and XI. in these terms, the results do not agree so well together as when expressed in terms of the gramme metre; there is a corresponding difference in the values of the specific gravities, these latter have been very carefully determined, repeated with the results given.

Wires, therefore, of the same resistance expressed for grammes per metre may give a very different result, when expressed as per cubic centimetre; attention has been drawn to this fact in the discussion on the Elmore copper in the *Electrician*\*. M. Roux, of Paris, in a letter gives the following table for high conductivity wire, from a paper of M. Hospitalier in *L'Electricien*, 1887; this paper I have, unfortunately, not been able to see.

Density ... ..	8·897	9·32	9·6
Conductivity equal volume	102·4	106·7	110·8
Conductivity equal weight	101·7	101·2	101·6

What is 100 in the conductivity units is not expressed. M. Roux thinks that the former is the more rational method of expressing the result, i.e., for one of equal volume.

Matthiessen expressed all his results in terms of equal weight, justifying it by the greater accuracy obtainable when working with small weights of wires. Small errors in the value of the specific gravity are easily made, and cause a similar error in the result for equal volumes of different wires; unless working with long lengths of thick wire the weight of the wire is small, and the weight of the water displaced cannot be determined within ·5 to 1 milligramme, and that only with care: this error in ·5 of a gramme means only an accuracy of 1 in 500. The values given in my table are probably correct to 1 in 1,500 or 1 in 2,000, as the weight of water displaced was in all cases over 2 grammes. Results, therefore, for resistances of wires of equal weight are the most trustworthy and, I think, also the most satisfactory if used to express the resistance of a material and not of any given wire.

Wires X. (1) and X. (2) are of the same copper, but drawn down separately X. (1) was beginning to fray, and another specimen of the same copper drawn down still further had on this account to be rejected; this has affected the resistance value expressed in both ways. Thus

X. (1)	...	·1573	...	1767
X. (2)	...	1569	...	1751

but much more so when expressed for equal volumes. In both the copper is of the same quality.

It will be noticed that with increase of specific gravity there is a decrease of resistance, even when the results are expressed for wires of equal weight; the resistance diminishes, therefore, more rapidly than the density increases. Wires, therefore, of the same quality may, in consequence of a difference in drawing, have a different density, and so the results expressed in terms of equal volume will differ considerably; while those for equal weight are the same, or approximately so.

The values obtained for IX., X. and XI. are so nearly identical, that it is not unfair to conclude that they are samples of pure copper; their value is identical with that obtained by Matthiessen at, I believe, the same temperature. The greater difference obtained at 0° C. between Matthiessen's value and samples of copper tested now at that temperature, is probably due to the fact that Matthiessen's value was not determined at 0°, but reduced in value for that temperature from observations, as stated above, at about 20° C.

The higher conductivity or less resistance for the two samples given in the table is due not to increased purity in the preparation of the copper, but in the difference in the process of preparation, whereby a sample of greater density is obtained than results from the working up of small quantities of copper in the laboratory.

A sample of copper has been prepared by chemical means with the help of my friend, Mr. Skinner, but has not yet been measured.

The discussion on this paper and others will be given in a later issue.

## NOTES ON THE VULCANISATION AND DECAY OF INDIA-RUBBER.

By WILLIAM THOMSON, F.R.S.Ed., F.C.S.

(Read before Section B., September 10th, 1890.)

UNDER ordinary conditions India-rubber for vulcanising is usually mixed with sulphur and heated to a high temperature, when chemical combination takes place between the sulphur and the

\* B.A. Report, 1864, or *Phil. Mag.*

\* *Electrician*, December 7th, 1888.

rubber, producing a much more valuable compound for ordinary purposes than unvulcanised rubber, the former remaining plastic at very low temperatures and firm at high temperatures, whilst the latter becomes hard and quite soft respectively at those temperatures.

In making cloth for waterproof garments another method is employed for vulcanising the rubber, viz., by wetting its surface with a mixture of somewhere about 5 to 10 parts of chloride of sulphur dissolved in 100 parts of bi-sulphide of carbon and then heating the fabric gently to evaporate away the excess of these substances: the rubber-covered cloth cannot be heated to a high temperature like the rubber alone, because the heat would be liable to injure the cotton, silk or wool of the fabric, or destroy or injure the colours.

The bi-sulphide of carbon softens and penetrates the fine layer of rubber, carrying with it the chloride of sulphur dissolved in it, and it is generally supposed that the chloride of sulphur breaks up, the sulphur combining with the rubber, producing vulcanisation, and the chlorine combining with the hydrogen producing hydrochloric acid, which is liberated. This reaction is clearly not the correct one, and it is probable that the reverse is more in accordance with the facts, viz., that the chlorine of the sulphur chloride combines with the rubber, producing vulcanisation, leaving the sulphur in the free state, or only partially in combination with the rubber, because in rubber vulcanised by the cold process I have found free sulphur to be present.

From a piece of rubber-covered cloth I separated the rubber and submitted it to analysis by mixing it thoroughly in small pieces with pure sodium carbonate and igniting, then dissolving the whole in water and adding to it peroxide of hydrogen previously treated with excess of barium-chloride (to separate sulphuric acid or sulphates). The peroxide ensures the conversion of the lower oxides of sulphur into sulphuric acid, whilst the excess of barium chlorides precipitates the sulphuric acid in the solution which is then weighed as barium sulphate.

Another portion of the made up solution was neutralised and the chlorine present titrated. The rubber, previous to ignition as above described, had been well boiled in water and dried to separate any hydrochloric acid which might be present, but only a faint trace of chlorine compound could be thus separated from the rubber.

The total sulphur present in the rubber amounted to 2.60, and the total chlorine to 6.31 per cent.

The yellow-coloured sulphur proto-chloride is best adapted for vulcanising, because it does not act too strongly upon the rubber, whilst the dark coloured chloride of sulphur containing, as it does, a large quantity of the higher chlorides of sulphur, is liable to render the rubber quite hard by vulcanising it too much. The theory generally adopted to explain this is, that these higher chlorides break up easily, liberating their sulphur which thus combines in greater quantity with the rubber, but my experiments and analyses prove that it is chiefly the chlorine and not the sulphur of the chloride of sulphur which produces the vulcanisation.

A rubber substitute, much used at present, is produced by acting on vegetable oils such as rape, linseed, &c., with a mixture of chloride of sulphur and bisulphide of carbon; the oil becomes converted into a solid substance resembling India-rubber to some extent, but being much more brittle. This body is now used in large quantity for mixing with India-rubber for the purpose of cheapening its production. On analyses of some samples of this material I have invariably found that it contained a much greater proportion of chlorine than of sulphur, and this process, therefore, is a vulcanisation by chlorine rather than by sulphur.

Recently I analysed three samples of rubber substitute, the one termed "special," another "spongy" India-rubber substitute, the third being similar to the first in appearance. The first contained of sulphur 3.4 and of chlorine 7.6 per cent.; the second contained of sulphur 4.56 and of chlorine 8.22, and the third 2.67 of sulphur and 7.90 of chlorine per cent.

These rubber substitutes contain considerable quantities of oily matters soluble in ether which I have also found to be chlorine and sulphur compounds of the oils. The first yielded 20.0 per cent., the second 14.3, and the third 11.5 per cent. of these thick oily matters soluble in ether. This oily substance from the first sample contained 2.6 per cent. of sulphur and 6.1 per cent. of chlorine, whilst that from the second contained 2.97 and 6.87 per cent. of sulphur and chlorine respectively.

Some rubber manufacturers regard this oily matter as injurious to the rubber, and reject any substitute which contains any considerable proportion of it. I have found, however, by experiment, that this oily compound, instead of acting injuriously on India-rubber, actually acts as a preservative of it. Some rubber threads were smeared with this oily extract, some with ordinary (unvulcanised) rape oil, and some left untreated; these were put into an incubator at 150° Fahrenheit for a few days, when it was found that the oil-treated rubber was quite soft and rotten, whilst the other two had remained sound. After a few days, more the original rubber thread had become quite rotten, whilst the threads smeared with the oily part of the vulcanised oil remained quite sound.

The first and second samples of rubber substituted were examined for soluble chlorides or hydrochloric acid, by boiling in water, the first gave 0.18 per cent of chlorine soluble in water, and the second 0.05 per cent.

It has been known for some time that copper salts exert a most injurious influence on India-rubber; copper salts are sometimes used in dyeing cloth which are afterwards employed for waterproofing with India-rubber, and it seems quite astonishing what a

small quantity of copper is required to harden and destroy the rubber; and the destructive effect of copper is further enhanced if the cloth contains oily matters in which the copper can dissolve. As an example, here is a piece of cloth alleged to have damaged the thin coating of India-rubber on it. I found it to contain copper, and with a view of demonstrating this point I took one piece in its original condition; to the end of this I pasted a similar piece of the cloth from which the oily and greasy matters had been removed by ether, and to the end of this, again, I pasted another piece of the same cloth from which I had removed both oily and greasy matters and copper; these three pieces joined into one were then coated in the usual way with India-rubber, and then hung in an incubator at 150° Fahr.; in the course of a few days the rubber on the original cloth had become soft, and it then hardened and became rotten and useless; the second piece from which the greasy matters had been removed then became quite hard and rotten, whilst the part from which both greasy matters and copper had been removed has remained in a perfectly elastic and good condition.

Prof. Dewar observed, accidentally, that metallic copper when heated to the temperature of boiling water in contact with the rubber, exerted a destructive effect upon it. With a view of finding whether this was due to the copper *per se*, or to its power of conducting heat more rapidly to the rubber, I laid a sheet of rubber on a plate of glass and on it placed four clean discs, one of copper, one of platinum, one of zinc, and one of silver; after a few days in an incubator at 150° F., the rubber under the copper had become quite hard, that under the platinum had become slightly affected and hardened at different parts, whilst the rubber under the silver and under the zinc were quite sound and elastic. This would infer that the pure metallic copper had exerted a great oxidising effect on the rubber, the platinum had exerted a slight effect, whilst the zinc and silver respectively had had no injurious influence on it. A still more curious result was this, that the rubber thus hardened by the copper contained no appreciable trace of copper, the copper therefore presumably sets up the oxidising action in the rubber without itself permeating it. I have pleasure in acknowledging the assistance rendered to me in these experiments by my assistant, Mr. Frederick Lewis.

#### A NEW DIRECT READING PHOTOMETER MEASURING FROM UNITY TO INFINITY.

By FREDERICK H. VARLEY, M.I.E.E., F.R.A.S.

(Read before Section A, September 10th, 1890.)

The object I had in view in designing this apparatus was to meet a want that has been felt by electrical engineers and others interested in the measurement of light, namely, a convenient form of apparatus as handy to manage as the usual set of measuring instruments which are provided, so as to take its position along with the voltmeter, the ammeter and the wattmeter.

Incandescent lamps are now made of such generally uniform construction that if we can, with facility, measure the light produced, we can readily deduce, for all practical purposes, the amount of current delivered, and thereby determine the general efficient working of the installation. Or, conversely, if we know the current in watts passing through a glow lamp, we can determine the suitability of the filament for the purpose required, provided we can readily obtain photometric measurements. The conditions imposed are, that the instrument should be portable, have a range from one candle-power to that of the electric arc, that the light to be measured, and that of the standard, should be exactly at the same distance from the screen.

This instrument consists of two discs, each pierced by two semi-ring-shaped windows or apertures. These openings extend to the half circle (180°); both are of the same width, 1 inch broad. The openings in the two discs are placed in reverse positions to one another, so that if one half-ring is opened to its full extent (180°), the other half-ring is entirely closed; or, if the discs are shifted to an intermediate position, both apertures will be opened to an equal extent—namely, 90°.

If, in this position, the discs are rotated, it is obvious that an equal amount of light can pass through both rings, but if the light to be measured is as 1 to 17 C.P., then the angular length of the two apertures must bear a proportionate ratio in order that the two shadows shall be of equal density; and accordingly, one aperture will be open to the extent of 10° for the brighter light, whilst that of the standard light is opened 170°. Instead of dividing the circle into the conventional 360°, I divide the half circle into 2,000 parts, this giving a range from 1 to 1,999, or 2,000 in round numbers. By still farther shifting the discs, this aperture may be entirely closed and read up to infinity. The divisions of the half circle are numbered from left to right and right to left, showing at once the fraction values of the angular extent of the opening or arc, and thereby giving the values of the light.

In order to make the discs turn one upon the other, I have devised a modification of the Fergusson paradox; that is to say, the discs are carried by independent shafts, one of which is hollow to allow the central axis to turn within it; at the end farthest from the discs a cog wheel is fixed to each axis. By means of a sliding link the two wheels can be brought into gear with the axis also provided with cog wheels, each being the same diameter, but one is cut with 100 teeth, whilst the other has 99 teeth. Thus, upon rotating the discs, each revolution of the gearing wheels advances the discs, and so changes the proportion of the openings,

one decreasing whilst the other increases, and *vice versa*; this we can do until the two shadows are of equal density, or approximately so, when the final adjustment can be given by hand. Behind the windows two hollow cones are placed which have their axes directed to a point common to both, but at some distance in front of the discs where the two shadows fall upon the screen. A second or back screen is then placed at the mouth of these cones, over which it fits, and effectively cuts off one light from the other, so that on one side is, say, the electric light, and on the other the standard candle. The light from both passes through axes of their respective cones, and through the discs, and on to the screen upon which the shadow image is cast.

This apparatus, in its present form, has only just been received from Mr. Lege, who has constructed it for us, and Mr. Friese Greene and myself are arranging a series of experiments which, we hope, will prove useful in photography.

In the course of the discussion, Sir WILLIAM THOMSON stated that it was a question whether integration by sensibility is the same as if continuous light be employed. There is a general idea that they are the same, but the point had not been, so far as he knew, absolutely settled. He had compared sunlight with the light of a candle by means of a pinhole one millimeter in diameter at a distance of a few yards from the paper screen, whilst the candle was at a distance of a few inches; he employed the shadow method. He considered the piece of apparatus exhibited by Mr. Varley to be well devised, and hoped that at the next meeting of the association he would be able to give his results by both methods.

Prof. J. D. EVERETT said that in colour experiments it is assumed that the penumbra method, such as just presented, holds true, because of the consistency of the results.

Prof. G. F. FITZGERALD remarked that it has been calculated that if the energy of all the solar radiations falling upon the earth could be conserved and utilised, each square metre of the earth's surface would afford sustenance to ten individuals, so that—as someone, not an Irishman, had expressed it—"there would be so many people that there would not be room for anyone."

Dr. OLIVER LODGE stated that experiments had been made in Germany showing that a curious physiological effect of flickering light under certain conditions was the production of colour, and that the colour disappeared when the motion was increased.

Mr. FREDERICK VARLEY, in reply to the speakers, said that he was glad to hear from Sir William Thomson the results of his experiments in comparing the light of the sun with a standard candle, and thanked him for the suggestions and encouraging opinions he had expressed. He would point out that the great object he had in view in constructing this apparatus was to obtain a portable and readily worked instrument which could be set up in any room or laboratory. The working of the Bunsen photometer required a room more than a 100 feet long in order to measure a 10,000 candle-power arc light. After speaking of Prof. Ayrton's photometer, he pointed out that by means of the new apparatus, measurements of the electric arc light could be obtained in the space occupied by an ordinary table.

The following is an illustrated description (for which we are indebted to the *Photographic News*) of the apparatus referred to in the foregoing paper:—

Two discs, perforated by semi-ring-shaped openings, the breadth of which are equal, as shown in fig. 5, are mounted on an axis with

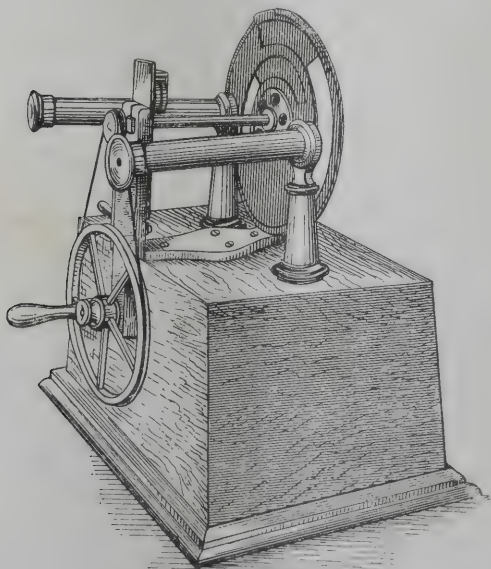


FIG. 4.

their openings reversed, so that when the outer half-ring is fully open (extending to 180°) the inner ring is entirely closed; or if the outer half-ring is open to 90°, then the inner ring will be opened to the same extent, as shown in fig. 6. In that case, when the discs are rotated, two complete circles are formed, through

which an equal amount of light will pass. Again, as in fig. 7, the outer ring is nearly open, and the inner one only partially so. As before, two rings are formed upon rotation, but the amount of light which passes through will be unequal, being, in fact, directly proportionate as the extent of the degrees of arc of the openings are to one another. If, say, the outer ring is opened 160°, and the

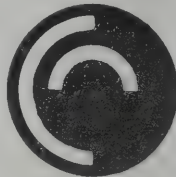


FIG. 5.



FIG. 6.

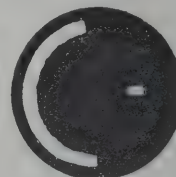


FIG. 7.

inner 20°, in order that the more intense light passing through the inner circle shall balance the standard light passing through the outer, all that has to be done is to read off the respective degrees and write them down in the form of fractions—that is,  $\frac{20}{160} = \frac{1}{8}$  from this we ascertain that the light is eight times more intense than the standard. Instead of the conventional division of the circle, we divide the half-circle into 2,000 parts, for the purpose of obtaining a finer or more extended range of reading up to 1,999 times; these divisions, by means of a vernier, can be further subdivided ten times, and read up to 20,000 candles in round numbers.

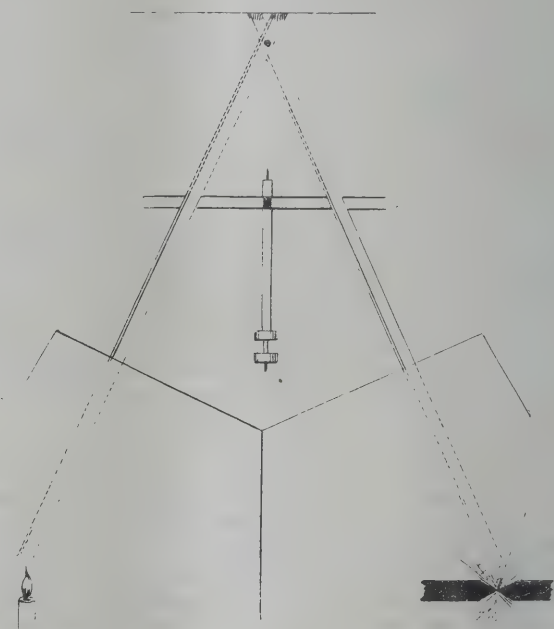


FIG. 8.

The breadth of the semi-ring-shaped windows in this instrument is one inch, and in front of the discs are two equal collimators, one of which projects a disc with a black centre, and the other a corresponding luminous spot. They are regulated so that when the light falling upon the screen from both sources is equal, a uniform disc is obtained; but if one or the other preponderates, a disc with a grey spot, or a grey marginal ring with a bright spot, indicates which of the two sources of light reaching the screen predominates.

In order to regulate this, it is necessary to open one of the windows and close the other until a balance is obtained. This is effected by bringing into play a modification of the well-known Fergusson paradox: the rear disc is carried by the central axis, and the front disc by a long sleeve fitting over it; both the central axis and the sleeve are provided with tooth wheels. Above these is an axis which carries two wheels, one with a hundred teeth, and the other with ninety-nine teeth, which are readily placed in or out of gear by a jointed lever; when in gear they cause the two discs to shift or turn upon each other, and so open or close the windows. It is convenient in some cases to dispense with the collimators, and determine the values of the light by comparison shadows, in which case a T-shaped screen is employed pierced with two holes each a circular inch in diameter, the centres of which are of a distance apart which corresponds with the mean diameter of the circular windows through which the light passes on to the screen. The middle partition forming the T prevents one light from interfering with the other. The apparatus is set in rotation by turning a band wheel, and the windows adjusted until the two shadows balance. The values are read off from the divided scale of 2,000 parts, which is numbered from left to right, and right to left, giving at once the fraction values of the ratios of one aperture to the other.

A COMPARISON OF A PLATINUM THERMOMETER  
WITH SOME MERCURY THERMOMETERS AT LOW  
TEMPERATURES.

By E. H. GRIFFITHS, M.A., Sidney College, Cambridge.

(Read in Section A, September 9th, 1890).

THE paper describes the mode of constructing an air-tight platinum thermometer for use at low temperatures. The thermometer was graduated by means of the freezing and boiling points of water, and as regards intermediate points Regnault's determinations of the temperature and pressure of aqueous vapour were adopted. The precautions observed in the construction of the apparatus, and in the method of observation, are described. The thermometer was tested by comparison with a number of thermometers standardised at Kew. The curves, showing the result of these determinations, are in remarkably close agreement, and when the observations were sufficiently numerous it appeared possible to calibrate the bore as accurately as by the usual more laborious process. The further advantage of this method is that thermometers can be compared under the conditions in which they are to be used.

In a communication to the Royal Society read on June 19th, 1890, I described a method of constructing and graduating platinum thermometers and gave a table of boiling and freezing points for various substances lying between 100° and 500°, determined by means of these instruments.

Subsequent observations indicate that a slight change appears to be taking place in the readings of these thermometers, I attribute this (1) to alterations in the glass, (2) to presence of moisture in the tube—the asbestos roll on which the spiral was wound being highly hygroscopic. I therefore decided to construct a thermometer in which there should be no contact between the glass and the platinum, and which should be thoroughly dry and hermetically sealed.

I was unable to discover any suitable non-conductor capable of resisting high temperatures; but in Anthracene (melting point 213°) I found a substance suitable in every respect for use at low temperatures. I subjected a sample to severe tests and, up to a temperature of about 130°, found it to be a better insulator than paraffin.

The leads to the coil were constructed of silver, the inner one a rod and the outer a tube. The resistance of these leads was about .001 ohm and, therefore, any change in the external resistance, caused by change of temperature, might be disregarded. The silver leads approached to within about one inch of the spiral and were connected to it by moderately thick platinum wires; thus a flow of heat from the spiral to the silver was diminished. The wire forming the coil was about fifty-six inches in length and had a diameter of .005 inch. The spiral was about 2 inches long having a resistance of about 13.5 ohms at 0° C., and the external diameter of the covering tube was about .3 inch. The ends of the Asbestos roll were made of greater diameter than the portion on which the spiral was wound, and thus there was no glass contact. The tube and contents were heated up to a temperature of several hundred degrees and dried air passed through it for some hours. It was then exhausted and the open end placed under the surface of melted Anthracene, which was allowed to rise until nearly in contact with the coil. When cool, the whole of the thermometer, from the spiral to the upper end (about thirteen inches) was a solid mass, while the spiral and asbestos roll were perfectly dry and in an almost vacuous space. I have taken nearly six hundred observations with this thermometer and cannot detect any signs of change. When the lower part was undergoing rapid changes in temperature, thermo-electric effects showed themselves, but by reversing the battery and galvanometer connections during each reading these effects were eliminated. A low resistance galvanometer was used, and the current, which passed through the thermometer when determining its resistance, did not exceed one hundredth ampere. To illustrate the closeness of the agreement in the results obtained at different times I give the following determinations of the resistance at 100° taken in the usual manner by means of a hypsometer with manometer attached. Full corrections were made in the barometric reading, and the results reduced to lat. 45°.

Date.	Temperature.	Resistance (after corr. for temp. of coils).
July 26 ...	100°C.	18.2029
" 27 ..	100°C	18.2034
August 12 ...	100°C.	18.2025
" 13 ...	100°C.	18.2031
mean		18.2030

The expression for the platinum temperature by this thermometer

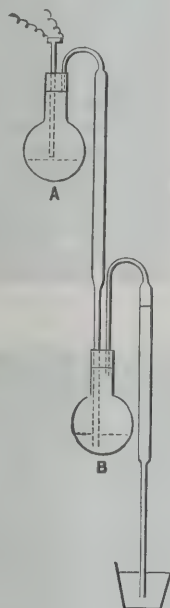
$$\text{was } \frac{(R - 13.5219)}{4.6811} \times 100, \text{ again } \frac{R_{100}}{R_0} = 1.3462,$$

almost exactly agreeing with the coefficient of the wire in Mr. Callendar's air thermometer (Phil. Trans. A 1887).

Mr. G. M. Clark, B.A. (Sidney Coll. Cambridge), now joined me in the investigation, and as we proposed to use this thermometer for the calibration and graduation of mercury thermometers between

0° and 100°, we decided to obtain intermediate temperatures by means of Regnault's numbers connecting the temperature and pressure of aqueous vapour. For this purpose we constructed a large iron tank with two plate glass sides, holding about 16 gallons of water, and through two holes bored in the bottom, inserted two barometer tubes, the upper 16 inches of each being within the tank. One of these was used as a standard barometer, and was prepared with great care, the distilled mercury, with which it was filled, having been boiled in the tube for more than 6 hours. The internal diameter of the tube was 14 m.m., and the absence of any meniscus was very marked. If the level of the surface of the water in the tank was below the top of the barometer, and the water warmed, the sublimation of mercury in the vacuous space was observable. The second barometer was made from the same length of tubing as the first, and communicated at its upper extremity with a small flask (A), in which was placed the platinum thermometer.

Distilled water was boiled in vacuo for some hours, to expel all traces of air. The flask and barometer tube were then exhausted by means of an air pump, and the lower end of the tube placed in a flask (B) containing the previously boiled water, which rushed up, filling the tube and flask (A).



The water remaining in (B) was then boiled until this flask and a bent tube passing from it into a basin of mercury, 30 inches beneath, were completely filled with steam, and, on cooling, the height of mercury in the tube enabled us to determine that the pressure on its surface was that of aqueous vapour only. The water in the upper flask was then boiled for many hours, and only allowed to cool occasionally to permit of the water in the lower flask being boiled away. To prevent access of air, the steam was driven off through the mercury. When the water in flask (A) was reduced to about a tablespoonful, the boiling was stopped, and the level of the mercury was raised until it flowed back first into flask (B) and thence into the barometer tube, as flask (A) cooled.

The open end of the barometer tube was then sealed, the flask (B) replaced by a small cup of dry mercury, and the end of the tube opened below the surface. The water remaining on the top of the column was driven back into the flask by pouring hot water over the tube.

During our experiments, water occasionally collected on the mercury, but by means of a concave mirror it was driven back into the flask; the mirror was of course removed sometime before an observation was taken.

The tank, filled with water, was maintained at any required temperature by means of a gas regulator. The lower parts of the barometer tubes were screened by sheets of asbestos, and the two cups were connected by a small siphon. The glass sides of the tank were covered with white paper to prevent radiation, openings were left for observations, during which, the water in the tank was kept in a continual state of agitation by the oscillation of a large paddle driven by a water motor. The paddle, fixed in one corner of the lid, swept across the tank driving the water before it and lifting it at the same time. We have tried several forms of stirrers, and we believe this to be a more effective form than a screw or a plunger.

The difference in the height of the mercury in the two barometer tubes, was ascertained by the kathetometer G. 33, in the Cavendish Laboratory, and by means of it, readings could be taken to .50 m.m. Care was taken to bring both levels horizontal before each observation.

As the co-efficient of expansion of the kathetometer scale was unknown, and the temperature of the room usually about 20°C., we decided to compare it with the standard scale R, whose co-efficient of expansion and scale errors had been determined by the Standards Department of the Board of Trade.<sup>1</sup>

<sup>1</sup> Standard metre, verified June, 1882, designated R in Mr. Chaney's report.

Twenty-one comparisons were made (greatest divergence from the mean .10 m.m.) and the result was as follows:—300.35 m.m. on kathetometer scale at 20° (=300.35489 of Board of Trade Standard (S.S.) at 0°.

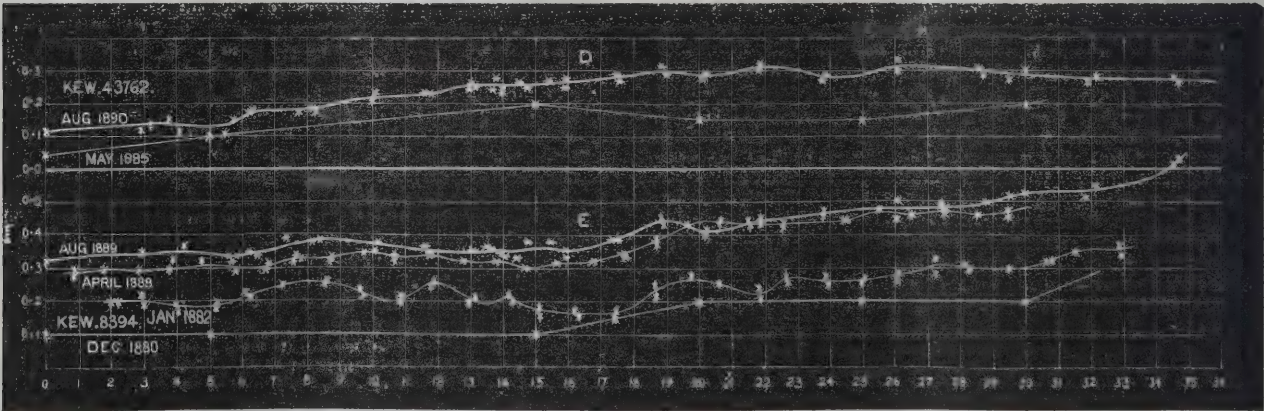
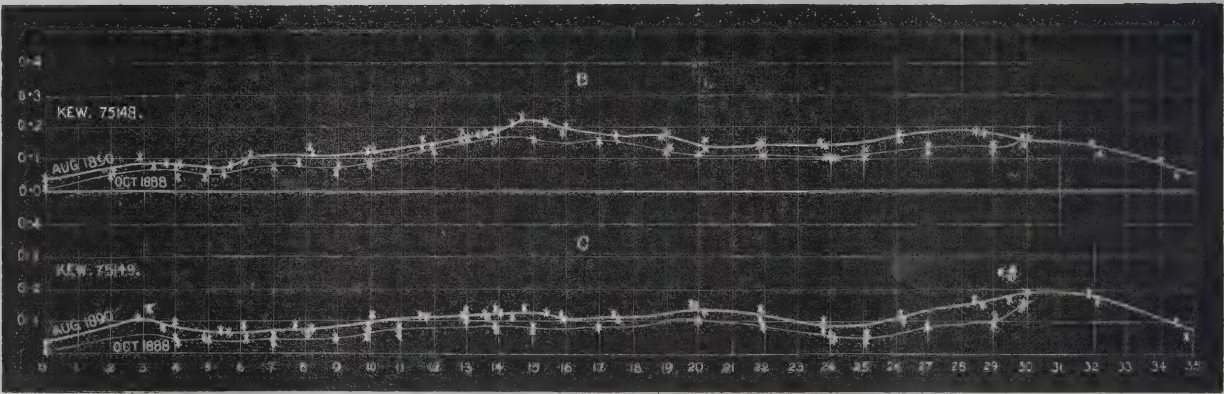
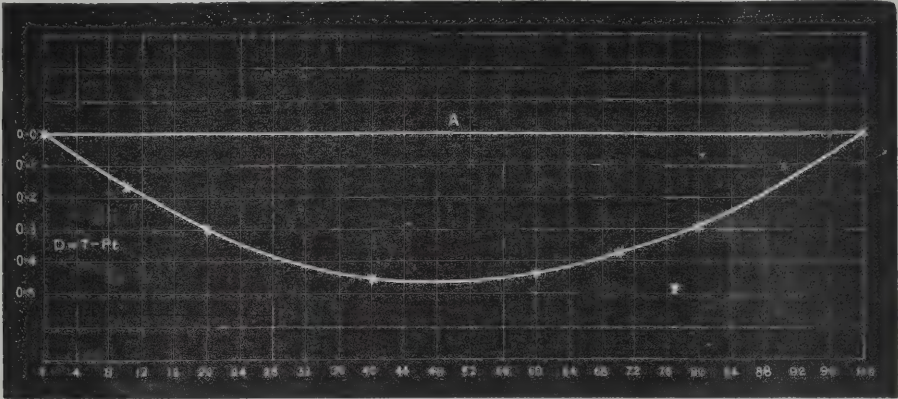
Thus no scale correction was necessary.  
The difference (D) of the mercury columns was corrected for temperature, pressure of mercury vapour and latitude and the resulting length denoted by  $D_0$ : the temperature corresponding to  $D_0$  was deduced from the very full table given in Part 3 of Carnelly's "Melting and Boiling Point Tables."

The extremities of the curve at (0° and 100°) having been determined, it was only necessary to get points between 30° and 80°.

Ninety observations were taken, and although occasional diver-

$y = .018795t - .0001991t^2 + .000,000,111.5t^3$ . the curve itself is shown in Chart A.

We proceeded to test our conclusions by comparison with thermometers standardised at Kew; for this purpose a rotating annular ring, through the centre of which the platinum thermometer passed, was inserted in the lid of the tank, in such a manner that the mercury thermometers, fixed in holes bored near its circumference, could successively be brought into the field of view of the kathetometer without any re-adjustment of the telescope; the thermometers were then read by one observer, whilst the platinum resistances were taken by the other. The freezing points were not, however, determined by this method, but by direct immersion in powdered ice, adopting the precautions recommended by Guillaume in his *Thermometrie de Précision*.



gences presented themselves, the mean path gives a curve which we believe to be within less than .02° of the true path at all points. It agrees closely with the curve obtained by Mr. Callendar from the parabola  $1.57 \left[ \left( \frac{t}{100} \right)^2 - \frac{t}{100} \right]$ , by measuring one tenth of the ordinate along the abscissa.<sup>2</sup>

meter temperatures.

The following equation, however represents its path more accurately.

<sup>2</sup> It must be remembered that Callendar's difference curve gives the connection between platinum and air-thermometer temperatures, whilst Regnault used a mercury thermometer (M.A.S. XXI.) and thus curve A gives the relation between platinum and mercury thermometer temperature.

The following curves were then drawn, which indicate the result of the comparison of our platinum thermometer with those standardised at Kew.

Curve.	Thermometer, Kew No.	Standardised.
B.	75148	October, 1888.
C.	75149	October, 1888.
D.	43762	May, 1885.
E.	8394	Dec., 1880; Jan., 1882; April, 1888.

All these thermometers were made by Hicks, the first three were kindly placed at our disposal by Mr. R. T. Glazebrook, the last is

one of those referred to by Mr. W. N. Shaw in a communication to the B.A. during the Bath Session, the successive curves of which, then exhibited by him, he has kindly allowed us to copy.

In these diagrams the abscissæ represent the temperature, in the strong curves, that obtained by us, and in the faint, that obtained by Kew; the ordinates in each case being the divergence of the actual readings from these results. Where crosses occur at almost identical temperatures they indicate observations separated by a considerable interval of time, in no case did less than 20 minutes elapse, whilst in others several days.

Three only of our observations are unrecorded on these charts, and in each case, owing to imperfect light, interruptions, &c., these experiments were regarded as doubtful before their results were deduced.

The gradual rise of the zero point is clearly indicated; apparent discrepancies are probably due to the fact that the Kew determinations are less frequent than ours, and as a consequence many of the smaller deviations have escaped notice.

The results show:—

- 1st. That thermometers whose range does not include 0° and 100° may have certain fixed points determined by this method.
- 2nd. That an actual calibration of a mercury thermometer can also be readily accomplished.
- 3rd. That the platinum thermometer, properly constructed, may serve as a standard by which to trace the changes which may take place in mercury thermometers.
- 4th. That since the readings of the platinum thermometer are independent of the extent of the stem-immersion, it can be conveniently employed for the graduation of thermometers partially immersed, as in ordinary use.

During the past few days, we have calibrated about twenty thermometers by this method, and we believe the results to be satisfactory in all cases.

### REPORT OF THE COMMITTEE ON ELECTRICAL STANDARDS.

(Read in Section A, September 9th, 1890).

#### LEGAL OHMS.

THE work of testing resistance coils has been continued at the Cavendish Laboratory. A table of value found for the coils is appended.

No. of Coil.				Resistance in Legal Ohms.	Temperature.
Nalder	...	1577	C.L.C. 189	·99981	16·9
Nalder	...	1573	C.L.C. 190	1·00089	16·9
Nalder	...	1579	C.L.C. 191	1·00041	16·9
Edison Swan	...	16	C.L.C. 192	·99846	13·9
Elliott	...	229	C.L.C. 193	1·00028	16·9
Elliott	...	230	C.L.C. 194	1·00021	16·9
Simmons	...	...	C.L.C. 195	·99992	16·8
Nalder	...	1626	C.L.C. 196	1·00045	15·3
Nalder	...	1627	C.L.C. 197	1·00056	15·3
Nalder	...	1628	C.L.C. 198	1·00058	14·8
Nalder	...	1580	C.L.C. 199	1·00072	15·3

#### B.A. UNIT.

It would be of considerable advantage in the testing if all the coils were made of a uniform size. The original Standards of the Association measure  $6\frac{3}{4}$  inches from the bottom of the case to the underside of the horizontal portion of the copper connecting rods, while the vertical portion of these rods is 8 inches in length. These dimensions should be adopted in all coils sent to be tested; if this be done the baths, &c., made to hold the standards hold the coils equally well, and the additional convenience in testing is very great.

The original Standards of the Association have again been several times compared among themselves.

The results of the comparisons appear to show that while the coils A, B, C, D, E, and Flat have remained constant relative to each other, the three platinum silver coils F, G and H have changed.

The change in F was referred to at the end of the Report in 1888, and is now very large. The coil has increased in resistance by about ·0006 B.A. units; G, on the other hand, has fallen by about ·0002 B.A. units, and H by about ·0001 unit. The evidence for these various statements is given in an appendix to the Report by the Secretary.

It is perhaps worth remark that in each case the change either took place during the time that the coil was immersed in ice or was found to have happened when the coil was next measured after its removal from the ice.

The legal ohm coils have not varied relative to Flat.

The investigations into the resistance of copper have been continued by Mr. Fitzpatrick. The Committee desire again to thank the gentlemen who have rendered him assistance in various ways.

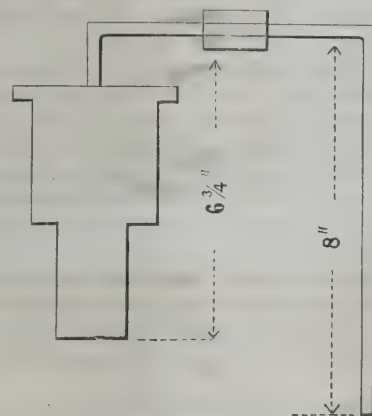
Mr. Fitzpatrick has examined various specimens of copper supplied him as wire. He has also examined copper prepared for him as pure by Messrs. Sutton, as well as some which he prepared himself electrolytically from carefully purified copper sulphate. These last two specimens lead to practically the same value as that obtained by Matthiessen for the specific resistance of copper—viz.,  $1767 \times 10^{-9}$  B.A. units at 18°, the specific gravity of these specimens is about 8·90. Two wires supplied to him have, however, a distinctly lower resistance: the value for one being  $1731 \times 10^{-9}$  and for the other  $1724 \times 10^{-9}$ ; a difference in the one case of 2 and in the

other of 2·4 %. The specific gravity of the first of these wires is 8·940 and of the other 8·946, and Mr. Fitzpatrick assigns the increased conductivity to increased density rather than to greater purity.

Matthiessen gives his results for the resistance of copper at 0°. The observations were, however, made mostly at a temperature of 18° or 20°, and reduced to 0° by the use of a temperature co-efficient. So that the value at 18° found from that at 0° by the same co-efficient will probably represent the result of Matthiessen's work more accurately than the one he gives himself. Various other points of importance are discussed in Mr. Fitzpatrick's appendix. He hopes to be able to give the results for some copper prepared by chemical means by Mr. Skinner and himself. He has also made a number of measurements on silver, but these are not yet complete.

Dr. Muirhead and the Secretary have both been working independently at the construction and measurement of a standard air condenser.

Two such condensers have been made for the Committee by the Cambridge Scientific Instrument Company, on a plan suggested by Dr. Muirhead, and mentioned in the last Report. The capacity of each of these is about ·02 microfarad. Some slight alterations are required to one of these, the other is completely satisfactory. Its capacity has been repeatedly found, and remains constant to at least within 1 in 2,000, which is about the limit of accuracy attained. Its insulation resistance is good, the loss by leakage being about 1 in



1,000 of the total charge per 1 minute. It has been found possible to compare readily with this standard various mica condensers having capacities of 1, ·5, ·1, and ·05 microfarad. The accuracy of these determinations is about 1 in 2,000. A full account of the construction of the condensers, and of the method of making the various tests, is given in an appendix by the Secretary, while Dr. Muirhead has contributed some notes on his own condensers and tests.

Another appendix contains an account of a very careful and interesting comparison between the standard mercury thermometers of the Association and a platinum resistance thermometer constructed by Mr. E. H. Griffiths. The resistance thermometer was graduated by means of Regnault's numbers for the vapour pressure of water at various temperatures between 0 and 100.

The curve of corrections obtained in this way is exactly parallel to that given by the Kew comparisons; there is throughout the range a constant difference of 0·02 between them. This amount is within the limits of error on the mercury thermometer.

The question of the best value to adopt for the dimensions of a mercury column having a resistance of one ohm has been raised by some members of the Committee during the year. There is no doubt that the column of 106 centimetres adopted by the Paris Conference in 1884 is too short.

After a discussion of the results of the most recent observations, the following resolutions were adopted by the Committee:—

(1) The Committee recommend for adoption as a standard of resistance sufficiently near to the absolute ohm for practical purposes the resistance of a column of mercury 106·3 c.m. in length 1 square mm. in section at a temperature of 0° C.

(2) That for the purpose of issuing practical standards of resistance the number ·9866 be adopted as the ratio of the B.A. unit to the ohm.

Thus the new unit may be obtained from the B.A. unit by increasing it in the ratio ·9866 to unity, or, to put it differently, the specific resistance of mercury in B.A. units is taken as  $·9535 \times 10^{-4}$ , and the length of a column of mercury which has a resistance of one B.A. unit as 104·97 c.m. The specific resistance of mercury in ohms is  $·9407 \times 10^{-4}$ .

In conclusion the Committee wish to ask for reappointment to enable them to continue the work of constructing and issuing standard instruments. Of the grant of £50 made at Newcastle only £12 17s. has been drawn. In order to check any further change in the values of the B.A. units, and to render it less necessary to employ the original standards in all the comparisons which are made, it is desirable that the Committee should possess three or four copies of the B.A. unit; while, to enable comparisons to be made between the new air condensers and condensers of capacity compatible with a microfarad, a resistance box going up to several hundred thousand ohms is required.

The Committee are of opinion that they should be in a position to purchase these resistances; they therefore recommend that they be reappointed with a grant of £100, that Professor Carey Foster be the Chairman, and Mr. R. T. Glazebrook Secretary.

LIQUID INSULATION FOR UNDERGROUND  
CONDUCTORS.

By DAVID BROOKS.

THE first work on this system for practical purposes was laid for the English Post Office in 1880, along the South Western Railway between Waterloo Station and Clapham Junction.

It consisted in boiling cotton covered conductors in paraffin oil and drawing them into  $1\frac{1}{4}$  inch diameter iron pipe and afterwards filling the pipe with oil. There were 40 conductors of No. 18 B.W. gauge. Reservoirs were placed at elevated positions at Clapham and Waterloo to supply the loss of oil from leakage. The oil used was the ordinary petroleum fluid. The only difficulty experienced was from leakage through the joints of the pipe. This was remedied by the introduction of a heavy rosin oil of the consistency of the thicker grades of molasses. It has been working without interruption for the past ten years.

An improved method was patented February 1st, 1887. In the spring of that year 53 conductors were laid along the Pennsylvania Railroad, between the Broad Street Station and 32nd Street, in Philadelphia, a distance of one and one-third miles. Instead of the ordinary sockets, a T-joint is used where the insulation is introduced through a plug hole, which occurs at every length of pipe, or about 20 feet apart.

The insulation now used is almost a solid, at a temperature of  $32^{\circ}$  Fah., but as the temperature rises it becomes more liquid, and, being sufficiently heated in a caldron, is turned in at the T-joints. No stand pipe or reservoir is used.

The advantages of this insulation are :—

1. It is heavier than water and is not penetrated by it.
2. Always being liquid it does not crack, or contain small fissures for the admission of dampness.
3. It is not easily punctured by atmospheric electricity or currents of high voltage.
4. The insulation expands and contracts by every change of temperature, and thereby prevents the current centering upon any weak portion and developing a fault, as is often done in other kinds.

Other advantages of the system are :—

1. *Mechanical Strength.*—The wrought iron pipe is proof against penetration or injury by workmen's tools in street repairing.
2. *Cheapness.*—Iron pipe has five times the capacity of lead pipe of equal cost per foot, without making allowance for its greater strength and durability.
3. It is often said of conduits as compared with this system, that there are extra ducts for an increase of conductors when necessary. If the total cost of any conduit, including manholes, is divided by the number of ducts, the cost per foot is ascertained. Each duct of itself costs twice as much as the total cost by the liquid system, using all the conductors that the duct is capable of containing.
4. Conductors can be looped out of the pipe at any desired point to street lamps or for house-to-house purposes, by simply unscrewing a plug and inserting a smaller pipe, very much as gas or water is introduced.

When the cable was laid on the Pennsylvania Railroad, they had use for only 25 conductors, which left 28 idle. Since then, increase of business has brought five more into use. Provision was made for an increase. Extra conductors can be drawn into the pipe when the cable is laid, much cheaper than providing a place for them, as is done in the conduit system.

In the preceding article regarding conduits, the objections made to them are entirely obviated by the use of this system, inasmuch as the insulation is hermetically sealed from the effects of damp air and gases.

The cable laid at Gloucester is now working with a potential of 3,000 volts, alternating between conductors which are in the same pipe. It has 22 terminals exposed to the weather, and the insulation, making allowance for temperature, is as high as when first laid.

## NOTES.

**Electric Lighting in Berlin.**—Some notion may be arrived at of the extension of electric lighting systems in Berlin from the following figures :—

August of ...	1885	1886	1887	1888	1889
Ampères ...	1,462	5,875	7,827	13,290	22,000

**The Electric Light in Libraries.**—At the meeting of the Library Association of the United Kingdom held last week at Reading, Mr. W. H. Greenhough, the librarian at Reading, in a paper on "The Ventilating, Heating and Lighting of Libraries," drew attention to the evil effects of gas used in reading rooms. There is great need of improvement in most reading rooms with which we are acquainted. Too often, they are pleasant places rendered dangerous by the hot, stifling air. A large quantity of light must be supplied, and, consequently, gas brackets are placed in every accessible corner. We imagine that nowhere are the deleterious effects of gas felt more than in reading rooms. As to libraries it is a most important matter for those responsible for books to see that the wear and tear of their treasury is mitigated, and by using the electric light, bindings would be kept in good condition for an infinitely longer period than would be the case under a gaseous régime.

**Lighting of Reading Library.**—The Reading Library Committee has entered into a contract with the Electric Light Company specifying that the sum of £80 per annum should be paid for the supply of the current to the eight arc lamps to be used in the library and reading rooms, for providing the necessary carbons, and for keeping the lamps in order. The total illuminating power at the library is to be equal to 4,320 candles. The cost of gas formerly consumed in the library was £79 odd, while the total illuminating power was equal to some 1,360 candles. The result of the experience gained at Reading showed that, excellent though the electric lighting method was, yet, owing to the flickering and occasional failure of a lamp to light from one cause or another, it could by no means be said to be perfect.

**Electric Headlights on Locomotives.**—Electric headlights will be used in future on all passenger trains of the Louisville, New Albany and Chicago Road Railway.

**Electric Lighting in Havana.**—Reports to hand show that electric lighting is progressing rapidly. Some two years ago a local company was formed to work on the Westinghouse system. An apparatus, consisting of two 750 alternate current dynamos, was at once installed at the new central station; but before the wiring had been completed, so numerous were the demands for the supply of light, that the company immediately telegraphed to the United States for an alternating current plant for a capacity of 3,000 incandescent lights. Since this was erected the company have done good business and the demand will soon again exceed the supply. The Westinghouse Company is preparing further plant for shipment.

**Electric Lighting in Madrid.**—The Electricity Supply Company for Spain, acting under a concession from the local authorities, has recently erected a central station in Madrid, and houses at a distance of two miles from the works are being satisfactorily lighted. The cost of the station is £80,000, and the electricity is distributed by underground mains. The station is on the same lines as those proposed for Leeds by the Yorkshire House-to-House Electricity Company, being similar to the one erected by that company's engineers at Kensington.

**Light at the Gold Coast.**—The electric light is being used at the Gold Coast to assist the Apolite Company's quartz crushing operations. The installation comprises 15 arc lamps.

**Continental Lighting.**—The Railway Station and Post Office at Ulm will be lit by electricity after December 1st next. At Florence the municipal authorities are in treaty with the International Electricitäts Gesellschaft of Vienna for the establishment of an electric central station outside the city on the Ganz system for 10,000 lamps.

**Electric Lighting at Tiverton.**—At the last meeting of the Tiverton Town Council, it was resolved to appoint a committee to take into consideration the best means of carrying into operation the powers conferred upon the council by the Tiverton Electric Lighting Order, 1890. It was mentioned by Mr. Grason that the electric light would be cheaper than gas.

**Electric Lighting at Weybridge.**—An installation of 170 lamps has been made at Brooklands, Weybridge, Surrey. The engine-house is situated about a quarter of a mile from the mansion. The plant consists of a new 10 H.P. Marshall's locomotive boiler, fed by a Worthington pump, supplying, at 80 lbs. pressure, an old form of horizontal steam engine made by Hayward and Tyler, hitherto and still used to drive a circular saw. At night the engine is employed to drive a shunt wound dynamo, by Mackie, giving a current of 60 am-pères at a tension of 150 volts. The current is conveyed to the house by underground lead-covered cables, protected by glazed pipes with cemented joints. The installation has proved in every way a success.

**Personal.**—Mr. A. J. Howes is about to set out for Cairo, to undertake the erection of an electric installation at the Mena Hotel, Cairo.

**Fire.**—We are desired by Messrs. Cathcart and Peto to state that the recent fire at their Hatton Garden works will in no way interfere with their business.

**Water Power for an Electric Light Station.**—We have, on a former occasion, referred to the projected central station at Innsbruck, in Austria, and we are now in a position to give a detailed account of the work, taking the figures from a lecture by Director Geyer, of Augsburg. The design and construction of this installation is that of Messrs. Ganz & Co., of Buda-Pest. There is a waterfall at Muehlau, near Innsbruck, capable of furnishing a maximum of 600 H.P. The fall is 117 metres, giving a pressure upon the turbines of about 11.5 atmospheres. The water is led through pipes, 350 millimetres in diameter, to a pair of vertical turbines of 160 H.P. each. These turbines run at 250 revolutions per minute, and are coupled, direct, to two alternators, each capable of producing 40 am-pères with 2,000 volts. There are two exciters running at 700 revolutions per minute, giving 60 am-pères and 110 volts. The present capacity is 2,000 lamps of 16 C.P. each. The high tension current is carried on overhead conductors (eight mm. diameter) to a distance of about four kilometres till it reaches the outskirts of the town of Innsbruck; from there the current is distributed through a concentric main 5.86 kilometres in length. Until recently, the distribution of current has been as follows:—

207 incandescent lamps, each 10 C.P., taking...	39 watts.
510 " " " 16 " "	56 "
79 " " " 32 " "	112 "
1 " " " 50 " "	195 "
1 " " " 100 " "	390 "
3 arc lamps ... ..	each 800 "
1 electric motor of 5 H.P.	
1 " " 10 "	
Total, 51,466 watts.	

The minimum consumption was 8,000 watts, and the maximum at any time 40,000 watts. The building of this central station is high up on a hill commanding a beautiful view, and it has been constructed of stones found in neighbouring quarries. For the purpose of transporting the machinery to the spot, special roads had to be cut, involving a good deal of labour. The entire work—buildings and installation—has been carried out in excellent style.

**Electric Fire Accident in Paris.**—Parisians and others who happened to be on the Boulevard des Capucines on Thursday evening, the 18th inst., were considerably startled by the sudden extinction of the electric lights, and the issuing of dense clouds of smoke from an opening in the roadway in front of one of the lamps. It appears that the underground system of the Compagnie Popp had taken fire at the part between the Rue Danon and the Rue des Capucines. This gave rise to some groundless apprehension of an explosion on the part of the public. The damage was repaired in a couple of hours, during which time the neighbourhood was in complete obscurity, to the great inconvenience of traffic.

**Cable Interruption.**—The French Government cable between Soussa and Sfax, on the coast of Tunis, has been broken. This cable was laid in 1882, and, considering the nature of the bottom, and the dangers which cables along this coast are subjected to at the hands of sponge fishers, it may be regarded as having lasted well.

**Lyons Tramway.**—Experiments have been successfully carried out on the Lyons Monplaisir-la-Plaine Tramway in adapting electrical propulsion to the ordinary tramcars. One of these cars was fitted with electric motors worked from 56 accumulator cells. A speed of from 12 to 14 kilometres per hour was maintained during the double journey between Lyons and the station at Monplaisir. The accumulators were made by the firm of Alioth, and are able to supply from 8 to 9 H.P. for eight consecutive hours. The comfort of the passengers was greatly increased by the car being electrically lighted.

**A New Telephonic Experiment.**—An experiment with the telephone is to be made in Birmingham next Sunday. Transmitters will be set up in Christ Church, New Street, so that subscribers to the telephone, if they desire, can hear the service and the sermon at their private residences. The general manager of the company has been encouraged to make the trial by the success which attended a similar scheme initiated by him eight years ago at Bradford. At the end of the choir stalls, on the top of the lectern at the reading desk, and at the pulpit desk, small metal cased transmitters will be placed, and they will be so regulated that sound vibration will be taken up without requiring the voice to be directed immediately upon the plate of the transmitter.

**Electric Welding.**—The wire for covering the tube of the new 10-inch gun, now in course of construction for the United States, is being joined by the electric welding process.

**Westinghouse Strike.**—The strike of the *employés* of the Westinghouse Company at Pittsburg was terminated on September 3rd by the capitulation of the strikers, who requested their old places.

**The Chinese Telegraph Convention.**—In the petition presented by the English merchants resident in China, many complaints are made against the cable companies. According to their statements, they have not derived the advantage which was to be expected from the two separate lines of the Eastern Extension and the Great Northern of Copenhagen, because the two companies, since 1875, have been working in combination, and maintained a rate of 6s. a word between Hong Kong and Europe. They can only communicate with America through Europe. The Convention of 1887 between the Chinese Government and the cable companies is referred to in bitter terms; the Government were, under this agreement, compelled to charge the same rate over their land lines to Europe as the companies. They beg that the Convention may not be ratified by Her Majesty's Government.

**Ship Wiring.**—The New York *Times*, of September 5th, commenting on a threatened fire on board of the *Etruria*, during a then recent passage across the Atlantic, caused by a short circuit in the electric leads, takes the opportunity of comparing the English and American methods of ship wiring, unfavourably to the former system. The article states that all the first-class liners running between England and the United States are wired on the single-wire system, in which the hull of the ship is utilised as the return wire, this plan being the cheapest way yet devised, owing to the large saving in copper, and from the inexpensive manner in which the wires are slung up, as well as from the small number of fusible plugs usually employed. In contradistinction to the danger that is ever present in a ship wired in the English fashion, the American method is so exhaustively perfect in every detail, that it is almost a moral impossibility for any accident, by fire or shock, to occur. The leads are protected first by the insulation, then by a lead covering to prevent corrosion, and, finally, by a wooden casing, from all mechanical injury. Fusible plugs are provided for each lamp. The junction boxes and cut-out boxes used in the American system of marine work are equally complete and much superior to the English construction. The boxes are waterproof and almost hermetically sealed, supplied with stuffing boxes and water-tight covers. Nothing but the cheapness of the English system can account for its criminal employment on the finest steamers in the world. So much from the New York *Times*, whose article reads like an excerpt from some glowing and gushing prospectus, the truth of which, at least in its practical development, may possibly be open to some doubt. In this doubt the gentleman who sent us the article joins, and is amazed at the presumptive tone in which it is couched, and further states, from a five years' experience, he believes that nearly all the wiring on the American side is simply slung up in the roughest manner. However true these statements may be, it is not improbable that the competition in securing contracts for ship lighting in England and Scotland does lead to inferior work and material being used on board ship, and, in the absence of efficient and thorough outside control in the selection of material, and of their proper disposition during the progress of the work, may eventually result in some serious disaster at sea.

**City and Guilds of London Institute.**—Prof. Ayrton's special course for *outside* students will be given every Monday and Wednesday, at Exhibition Road, at 3 p.m., commencing Monday, October 6th. The subject will be "The Construction of Direct and Alternate Current Dynamos and Motors, and the Methods of Testing their Power and Efficiency."

**Obituary.**—M. Gavarret, author of a "Traité d'Electricité," published in 1857, and of a "Traité de Télégraphie Electrique," published in 1849, and also of a treatise upon the electro-physiological researches of Galvani, published in the *Annales de Chimie et Physique*, has just died, aged 81.

**Electric Hair Curler.**—By the aid of this useful and beautiful invention, the hair, beard, or moustache can be curled in any style in one minute. It produces any form desired by ladies wearing their hair in the fashionable "loose and fluffy mode." Thus runs the wrapper of an article which has been submitted to our notice. We are told to hold the curler in the gas a few seconds, very little heat being required, on account of its highly magnetic qualities. Unfortunately our editorial hair, when worn, is neither "loose nor fluffy," and we must leave the testing of the instrument to others.

**The Story of Laying a Cable.**—Mr. Herbert Laws Webb, New York, will contribute to the October number of *Scribner's* an article entitled, "With a Cable Expedition," descriptive of the process of cable laying, and the life on board ship.

**French Telephones.**—M. Selves intends to reorganise the State service entirely. He proposes to suppress five of the eleven intermediary offices and establish one central office in their place. This central office will be occupied with the service of 6,000 of the total 8,800 subscribers, and will be located near to the Hôtel des Postes, at a cost of 800,000 francs, exclusive of building expenses.

**Jamaica Industrial and Manufacturing Exhibition.**—The contract for lighting this exhibition has been secured by Messrs. Nicholson and Jennings, of 7, Westminster Chambers, Victoria Street, S.W., who have tendered in accordance with the specification prepared by Mr. Kenneth Mackenzie, of 15, Great George Street, Westminster, who is acting as consulting engineer to the commissioners. This exhibition will be opened in January next, and will remain so for at least three months; being the first exhibition held in that part of the world, it is naturally creating considerable attention. The contract includes motive power and plant for an equivalent of 70 arc lamps and 650 glow lamps, or equal to an electrical output of 74,000 watts; and, since the buildings which are being erected will be spacious and of an elegant design, the effect, both in the interior of the exhibition as well as the ornamental grounds will be very striking. The contract also includes two electric motors of 20 H.P. each, for running some of the counter-shafting supplying power to exhibitors. The West Indies are at present, certainly as far as regards the enterprise of English electrical contractors, altogether untouched, since the greater part of whatever has been done there up to now has been supplied from the United States; and it is thought that a considerable impetus will be given to trade by the fact of this exhibition being organised by the government of the largest English colony there. We understand that Mr. Mackenzie will be glad to give information and particulars to any electrical firms who might feel inclined to utilise the advantages which this exhibition will offer for opening up a trade in the West Indian islands and Central America.

**The Electric Light on the German Railways.**—In Germany, on the railway lines on the banks of the Rhine, the electric light has been employed for some years with success. The *Voss Gazette* now informs us that the directors of the Prussian railways are about to light, as a trial, a certain number of carriages with incandescent lamps. Five of these lamps will be installed in each carriage. The intensity of the light can be regulated by the passengers as they wish.

**The African Telegraph Service.**—The first telegram direct from the German-African coast arrived last week in Hamburg. It was addressed by Serva Hadji to Captain Baron Von Gravenreuth, and ran as follows:—"Lauterberg from Bagamoyo. Gravenreuth Salaam. Serva Hadji. Two members of the telegraph staff have just left Marseilles for Dar-es-Salaam with a view to organising the telegraph service there."

**Dry Batteries.**—The following directions, with reference to a dry battery manufactured by an American firm, suggests that the name *dry* has been given by an inhabitant of the Emerald Isle. "To fully charge battery remove the cover and pour in slowly through the holes in the top *one gill of pure water*."

**Telephone and the Benwell Murder.**—So great is the interest in this case, that telephone wires have been connected from the Court to a neighbouring hotel. Transmitters are placed near the heads of the counsel, thus enabling the trial to be heard with distinctness. The wires, which almost obstruct the view, called forth a protest from the judge.

**Double-Cylinder Phonograph.**—An improved phonograph has been invented by an American which takes a record on two cylinders simultaneously.

**Electric Cars in Leeds.**—The Thomson-Houston Company has offered to equip a section of line in Leeds with electric cars, and pay a nominal rent of 100 guineas a year. If, on the expiration of two years, the Corporation decides to adopt electricity as the motive power upon the tramways, it will be able to take over the concern from the American company at a valuation. This will be no doubt favourably considered by the Highways Committee.

**The Electro-Harmonic Society.**—The concerts of this season—the fifth—will be six in number, and are announced to take place on the evenings of the following dates:—Friday, October 3rd, 1890, Smoking Concert; Friday, November 7th, 1890, Smoking Concert; Monday, December 8th, 1890, Ladies' Night; Friday, January 30th, 1891, Smoking Concert; Friday, February 27th, 1891, Ladies' Night; Friday, April 10th, 1891, Smoking Concert. At the first of the series Messrs. A. Thompson, W. G. Forington, W. Nicholl and Frederick Upton will perform, whilst the instrumental portion of the programme will be in the hands of Messrs. T. E. Gatehouse and Alfred Izard.

**Wade's Patent Arc Lamp Tablets.**—With the view of utilising the strong light of the arc lamp for advertising purposes, transparent tablets are now manufactured, lettered in various colours, and so made as to fit any type of lamp. Some are constructed of two bent



panels joined at the ends, forming an oval enclosure for the lamp, and others of four panels, forming a square enclosure for the lamp. They do not diminish the light, and are effective both by day and night. They are supplied by the Woodhouse and Rawson United Company, Limited.

**Telephone Induction Coils.**—The article on Telephone Induction Coils, which we give in our present issue, opens up an interesting subject. Those who have experimented largely with different forms and sizes of coils for telephonic purposes can hardly fail to have been struck with the extraordinarily small difference which is found to exist in the working qualities of the different types—long coils, short coils, coils of small diameter, coils of large diameter, coils with large cores, and coils with small cores all seem to give very nearly similar results; even the gauge of wire used in the primary and in the secondary makes surprisingly little difference. The cause of all this has, we believe, never been explained, nor attempted to be explained. Great hopes were entertained that coils on the transformer principle would give remarkably good results, but quite the contrary turned out to be the case, and the reason is now evident if it were not so before.

**Electric Lighting in Chelsea.**—In the report of the surveyor to the parish, we find the following remarks: There are in Chelsea actually using the electric light, about 139 houses supplied as follows, viz.:—

Chelsea Electricity Supply Co. ..	113 houses.
Cadogan Electric Light Co. ...	25 "
London Electric Supply Corporation ...	1 "
139	

It should be borne in mind that the desire for electric light in Chelsea is not, as in most parishes, an outcome of the electric lighting mania of 1882, but dates from some four years prior to that period, and that what at first sight looks like slow progress, is really the natural growth of an important industry which, in each stage of its advancement, bears marks of the careful attention bestowed upon it by the Chelsea vestry.

## NEW COMPANIES REGISTREED.

**Electrical Inventions Company, Limited.**—Capital, £35,000 in £1 shares. Objects: To acquire, work, develop and deal with patents of electrical inventions and improvements, and of electrical instruments and apparatus of every description, whether patented or not. Signatories (with 1 share each): W. Dare, 15, Stansfield Road, Stockwell; S. B. Witherby, 5, Holly Villas, Highgate; A. Good and A. W. Good, 57, Moor-gate Street; R. Radermacher, 16, Golborne Road, W.; Bruce Kedge, 29, Morrison Road, S.W.; C. Jellicoe, 74, Godolphin Road, Shepherd's Bush. The signatories are to appoint the first directors; qualification for subsequent directors, £190 in shares; the company in general meeting will appoint remuneration. Registered 18th inst. by A. W. Rixon, 10, Austin Friars.

**J. E. H. Gordon and Company, Limited.**—Capital, £50,000 in £10 shares. Objects: To acquire as a going concern the business of electrical engineer carried on by J. E. H. Gordon, M.Inst.C.E., and to construct, manufacture, supply, and maintain electric light machinery and apparatus. Signatories (with 1 share each): \*J. E. H. Gordon and Mrs. Gordon, 1, Queen's Gate Gardens; \*W. J. Rivington and Mrs. Rivington, 21, Gledhow Gardens, South Kensington; Mrs. E. C. Gordon and Miss E. C. Gordon, Hornlow Cottage, Campden Hill, W.; Hy. Sinclair, 11, Pall Mall. The signatories denoted by an asterisk are the first directors; qualification, 200 shares. Registered 19th inst. by Messrs. Mann and Taylor, 109, New Oxford Street.

**Combination Telephone and Electrical Engineering Company, Limited.**—Capital, £20,000, in £1 shares. Objects: To acquire and work the letters patent, Nos. 5,008 and 7,553, both of 1890, relating to telephones, and to take over as a going concern the business of Charles James Grist, carried on at 43, Sydney Street, Oxford Road, Manchester. To carry on the business of a telephone, telegraph and electric light, heat and power supply company. Signatories (with one share each): A. Lewis, 204, Elgin Avenue, W.; T. J. Cook, 4, Bovill Road, Forest Hill; H. C. Fowler, St. Paul's Road, Tottenham; H. T. Raw, 140, Birchanger Road, Woodside, S.E.; S. N. Smith, 68, Holmes Road, Kentish Town; T. E. Halford, 33, Priory Road, Bedford Park; C. Howard, 59, Lennox Road, Walthamstow. Messrs. C. J. Grist and E. Frank Fartado are appointed managing directors, each at a salary of £300 per annum. The ordinary directors will be entitled to £75 per annum each, with £45 additional to the chairman. Qualification, 50 shares. Registered, 19th inst., by Ernest Salaman, 65 and 66, Chancery Lane. Registered office, 35, New Broad Street.

**J. H. Holden and Company, Limited.**—Capital, £1,000, in £1 shares. Objects: To carry on business as cotton, wool, flax, hemp, jute and yarn merchants. To generate, use, let, or supply electric, gas, steam, or other power. Signatories (with one share each): J. H. Holden, Tonge; P. Crook, Bolton; W. Schmid, Bolton; F. T. Hilton, Bolton; Miss A. Nuttall, Bolton; P. Kirkham, Preston; Mrs. M. Holden, Bolton; all in

Lancashire. Registered, 19th inst., without special articles, by R. Jordan, 120, Chancery Lane. Office, Bradshawgate, Bolton, Lancaster.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**British Electric Propulsion and Traction Company, Limited.**—The annual return of this company, made up to the 18th inst., was filed on the same day. The nominal capital is £5,000, in £1 shares. 3,241 shares have been issued, 3,184 being considered fully paid. Upon 57 shares the full amount has been called and paid.

**Woodhouse and Rawson United, Limited.**—An agreement of 3rd inst. (filed 15th inst.) is supplemental to an agreement of 15th July entered into with Woodhouse and Rawson Electric Manufacturing Company, Limited (called the vendor company). The sale and purchase of the property referred to in the principal agreement has not yet been completed, for divers reasons, principally legal questions between the vendor company and other parties as to certain important assets. Until settlement thereof, it is deemed desirable that no steps should be taken for the liquidation of the company, and it is agreed to modify the terms of the principal agreement. It is therefore agreed that the purchase money payable shall be apportioned as follows:—

The plant, other than incandescent lamp plant ...	£5,250
The stock, other than stock of incandescent lamps ...	11,750
Patents and licences ...	11,000
Goodwill ...	3,500
Stock of incandescent lamps, and incandescent lamp plant ...	500
	<u>£32,000</u>

The sum of £23,000 is payable in ordinary shares and in fully paid shares.

An agreement of 3rd September (registered 15th inst.) with the Woodhouse and Rawson Electrical Supply Company of Great Britain, Limited, is also supplemental to an agreement of 15th July. For similar reasons the purchase consideration is modified until the settlement of the question involved, to £15,000, of which £12,500 is payable in fully paid shares.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Direct Spanish Telegraph Company, Limited.

THE report of the directors for the half-year ended 30th June, 1890, to be presented at the general meeting of shareholders, to be held on Tuesday, September 30th, 1890, states that the accounts show, after providing for debenture interest, a balance to the credit of profit and loss of £7,199 17s. 2d. The traffic receipts have again been satisfactory, and show an increase of £2,057 1s. 8d. as compared with the corresponding half-year of 1889. The working expenses are £391 0s. 8d. in excess of those for the corresponding period of last year. The company's cables, and the land-lines in connection with them, have continued in good working order throughout the half-year. The company was represented at the International Telegraph Conference held at Paris in May last, and had, as well as other telegraph companies and administrations, to submit to reductions of tariff which will affect the company's revenue to some extent. These reductions do not come into force until the 1st July, 1891.

An extraordinary general meeting will take place immediately after the ordinary general meeting, in accordance with the following resolution which was unanimously adopted by the shareholders at the last ordinary general meeting.

"That in the opinion of this meeting the directors' remuneration should be now increased beyond the sum of £400 per annum, and that in view of their declared intention not to avail themselves of their rights under the 71st of the company's articles of association as it now stands, the directors be, and are hereby requested, to give notice of a special resolution being brought forward at the next half-yearly meeting for altering article 71, so as to increase their remuneration to £600, or otherwise, as may from time to time be voted in general meeting."

Of the balance of profit and loss, £2,500 have been put to the reserve fund, which now amounts to £20,258 6s. 6d., leaving a

balance of £4,699 17s. 2d. Out of this amount the directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 6 per cent. per annum (free of income tax) on the ordinary shares. This will admit of a sum of £1,685 12s. 9d. being carried to the "contingencies account," which the directors consider it indispensable to maintain, in view of fluctuations of traffic, &c., the reserve fund applying solely to the renewal of the cables.

The dividend warrants will be issued on the 1st October, 1890.

### General Electric Power and Traction Company, Limited.

THE statutory meeting of this company was held at Winchester House, on Tuesday, Viscount Bury presiding.

The Chairman said his task was a purely formal one, the meeting being held, in pursuance of statute, for the purpose of giving the shareholders an opportunity of satisfying themselves, by personal communication with the board, at a short period after commencement of operations, that all the requirements of the various Acts have been complied with, and that everything is in regular and due order. He was happy to say that the affairs of the company were in complete order. No accounts had been issued, because it would be entirely premature to talk about what had been done or what was going to be done in the immediate future. A time would shortly arrive when the directors would have something to say upon those subjects. All he could tell them was that the company, which began as a going concern, was going on in a satisfactory manner. The directors had been constantly and energetically occupied with the various details of the factory, the mining branch, and the launches. The company's electrical cars were running in a satisfactory manner. The electrical works were under the management of Mr. A. T. Snell, who was well known as a most efficient and successful engineer, and who had occupied a high position under Mr. Immisch, at the "Immisch" works. They were very satisfactorily developing the mining plant, and had received very considerable orders in that department. Very satisfactory enquiries had been received from the various departments of electric traction, especially those devoted to tramways. In fact, the company had a future before it which, as he was not addicted to strong language, he would not call brilliant, but which he would call satisfactory, to his colleagues and himself.

A Shareholder would like to know to what extent shares had been taken?

The Chairman thought it was not a strictly regular question; it was certainly no part of the business of the present meeting. But, while anxious to keep within the usual routine, he saw no objection to saying that, with the exception of £8,000, the whole of the shares, ordinary and preference, had been allotted; and the whole proceeds of the preference shares would be devoted to the working of the company.

The proceedings then terminated.

### Elmore's Wire Manufacturing Company, Limited.

THE Stock Exchange has appointed to-day a special settling day for Elmore's Wire Manufacturing Company, Limited, shares Nos. 1 to 67,358, and has ordered the unmentioned securities to be quoted:—Preference shares, Nos. 1 to 50,000; Elmore's Patent Copper, vendors' shares, Nos. 1 to 23,300; Elmore's Wire Manufacturing Company, Limited, shares Nos. 1 to 67,358.

**Elmore's Copper Companies.**—The first batch of letters of allotment in Elmore's French Patent Copper Depositing Company, Limited, has been posted. "We," says a financial paper, "are informed that the issue has been subscribed nearly four times over, the actual number of shares applied for being 253,951." The shares are quoted 1½ to 1¼ prem. An Austrian Elmore's Copper Company is to be brought out in a few days.

**Stock Exchange Settlements.**—Application has been made to the Stock Exchange to appoint a settling day, and to grant a quotation to the International Okonite Company, Limited, preference shares, Nos. 5,667 to 17,000; ordinary shares, Nos. 22,667 to 34,000; and £517,000 6 per cent. debentures. *Woodhouse and Rawson United, Limited.*—Ordinary shares Nos. 1 to 31,416, and preference shares Nos. 40,001 to 54,285.

**Globe Telegraph and Trust Company, Limited.**—The directors have declared an interim dividend of 1s. 9d. per share, payable on the 18th proximo.

**Eastern Extension, Australasia, and China Telegraph Company, Limited.**—Interim dividend for June quarter of 2s. 6d. per share, payable on the 15th prox., has been declared by the directors.

## TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending September 19th, were £4,840.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 19th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,627.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (September 18).	Closing Quotation. (September 25.)	Business done during week ending September 25, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	98 — 101	99 <sup>1</sup> / <sub>16</sub>	...
1,549,160	Anglo-American Telegraph, Limited	Stock	51 <sup>1</sup> / <sub>2</sub> — 52 <sup>1</sup> / <sub>2</sub>	51 — 52	51 <sup>1</sup> / <sub>2</sub>	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	88 — 89	87 <sup>1</sup> / <sub>2</sub> — 88 <sup>1</sup> / <sub>2</sub>	88 <sup>1</sup> / <sub>2</sub>	88
2,725,420	Do. do. Deferred	Stock	15 <sup>1</sup> / <sub>2</sub> — 15 <sup>3</sup> / <sub>4</sub>	14 <sup>3</sup> / <sub>4</sub> — 15 <sup>1</sup> / <sub>2</sub>	15 <sup>3</sup> / <sub>4</sub>	...
130,000	Brazilian Submarine Telegraph, Limited	10	11 <sup>3</sup> / <sub>4</sub> — 12 <sup>1</sup> / <sub>4</sub>	11 <sup>3</sup> / <sub>4</sub> — 12 <sup>1</sup> / <sub>4</sub>	12	11 <sup>1</sup> / <sub>2</sub>
99,000	Do. do. 5 p. c. Bonds	100	100 — 102	100 — 102	102	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1 <sup>1</sup> / <sub>2</sub> — 2	1 <sup>1</sup> / <sub>2</sub> — 2	...	...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub> x d	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	...	...
\$7,216,000	Commercial Cable, Capital Stock	\$100	103 — 105	103 — 105	105	103 <sup>1</sup> / <sub>2</sub>
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	9 <sup>1</sup> / <sub>16</sub> — 1 <sup>1</sup> / <sub>16</sub>	9 <sup>1</sup> / <sub>16</sub> — 1 <sup>1</sup> / <sub>16</sub>	...	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	...	...
16,900	Cuba Telegraph, Limited	10	12 <sup>1</sup> / <sub>2</sub> — 12 <sup>3</sup> / <sub>4</sub>	12 — 12 <sup>1</sup> / <sub>2</sub>	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited	5	4 — 4 <sup>1</sup> / <sub>2</sub>	4 — 4 <sup>1</sup> / <sub>2</sub>	4 <sup>1</sup> / <sub>16</sub>	...
6,090	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9 <sup>1</sup> / <sub>16</sub>	9 <sup>7</sup> / <sub>16</sub>
60,710	Direct United States Cable, Limited, 1877	20	10 <sup>1</sup> / <sub>2</sub> — 10 <sup>3</sup> / <sub>4</sub>	10 <sup>3</sup> / <sub>8</sub> — 10 <sup>5</sup> / <sub>8</sub>	10 <sup>3</sup> / <sub>8</sub>	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14 <sup>1</sup> / <sub>2</sub>	14 — 14 <sup>1</sup> / <sub>2</sub>	14 <sup>1</sup> / <sub>2</sub>	14
70,000	Do. 6 p. c. Preference	10	15 — 15 <sup>1</sup> / <sub>2</sub>	15 — 15 <sup>1</sup> / <sub>2</sub>	15 <sup>1</sup> / <sub>2</sub>	...
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	...	...
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	104 — 107	104 — 107	105 <sup>3</sup> / <sub>4</sub>	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 <sup>1</sup> / <sub>2</sub> — 14 <sup>3</sup> / <sub>4</sub>	14 <sup>1</sup> / <sub>8</sub> — 14 <sup>3</sup> / <sub>8</sub>	14 <sup>5</sup> / <sub>16</sub>	14 <sup>1</sup> / <sub>8</sub>
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102	...	...
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	103 — 106	103 — 106	103	...
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	103 — 106	...	...
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	102 — 105	102 — 105	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7 <sup>3</sup> / <sub>4</sub> — 8 <sup>1</sup> / <sub>4</sub>	7 <sup>3</sup> / <sub>4</sub> — 8 <sup>1</sup> / <sub>4</sub>	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>4</sub>	...	...
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>4</sub>	6 — 6 <sup>1</sup> / <sub>2</sub>	7	5 <sup>3</sup> / <sub>4</sub>
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1 <sup>1</sup> / <sub>2</sub> paid)	2	...	1 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>4</sub>	...	...
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	5	2 — 2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>16</sub>	8 <sup>1</sup> / <sub>16</sub>
180,042	Do. do. 6 p. c. Preference	10	14 <sup>1</sup> / <sub>2</sub> — 15	14 <sup>1</sup> / <sub>2</sub> — 15	...	...
150,000	Great Northern Tel. Company of Copenhagen	10	15 <sup>1</sup> / <sub>2</sub> — 16 <sup>1</sup> / <sub>2</sub>	15 <sup>3</sup> / <sub>4</sub> — 16 <sup>1</sup> / <sub>4</sub>	15 <sup>1</sup> / <sub>16</sub>	15 <sup>3</sup> / <sub>4</sub>
40,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103	100 — 103	...	...
250,000	Do. do. (issue of 1883)	100	104 — 107	104 — 107	104	...
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	...	...
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	...	...
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 <sup>1</sup> / <sub>2</sub> — 19 <sup>1</sup> / <sub>2</sub>	18 — 19	18 <sup>1</sup> / <sub>2</sub>	...
200,000	Do. do. 4 <sup>1</sup> / <sub>2</sub> p. c. Deb., 1896	100	102 — 104	102 — 104	...	...
17,000	Indo-European Telegraph, Limited	25	36 — 38	36 — 38	37	36 <sup>1</sup> / <sub>2</sub>
38,348	London Platino-Brazilian Telegraph, Limited	10	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	...	...
100,000	Do. do. 6 p. c. Debentures	100	105 — 108	105 — 108	...	...
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4 — 4 <sup>1</sup> / <sub>2</sub>	4 — 4 <sup>1</sup> / <sub>2</sub>	...	...
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>16</sub>	4 <sup>9</sup> / <sub>16</sub>
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 — 12 <sup>1</sup> / <sub>2</sub>	12 — 12 <sup>1</sup> / <sub>2</sub>	12 <sup>1</sup> / <sub>16</sub>	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10 <sup>1</sup> / <sub>2</sub>	10 — 10 <sup>1</sup> / <sub>2</sub>	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	1 <sup>1</sup> / <sub>2</sub> — 2 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub> — 2 <sup>1</sup> / <sub>2</sub>	...	...
9,000	Reuter's, Limited	8	8 — 8 <sup>1</sup> / <sub>2</sub>	8 — 8 <sup>1</sup> / <sub>2</sub>	...	...
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	1 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> — ...	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	2 <sup>1</sup> / <sub>2</sub> — 3	2 <sup>1</sup> / <sub>2</sub> — 3	...	...
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117	...	...
78,949	Swan United Electric Light, Limited (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>16</sub>	5 <sup>1</sup> / <sub>2</sub>
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	43 — 45	44 <sup>1</sup> / <sub>2</sub>	43 <sup>1</sup> / <sub>2</sub>
150,000	Do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	...	...
55,000	United River Plate Telephone, Limited	5	3 <sup>1</sup> / <sub>2</sub> — 4	3 <sup>1</sup> / <sub>2</sub> — 4	3 <sup>1</sup> / <sub>2</sub>	...
146,000	Do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94	...	...
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10	...	...
300,000	Do. do. 5 p. c. Debentures	100	99 — 102	99 — 102	100	99 <sup>1</sup> / <sub>2</sub>
30,000	West Coast of America Telegraph, Limited	10	4 <sup>1</sup> / <sub>2</sub> — 5	4 <sup>1</sup> / <sub>2</sub> — 5	...	...
150,000	Do. do. 8 p. c. Debs, repay. 1902	100	101 — 106	103 — 108	106	105
64,572	Western and Brazilian Telegraph, Limited	15	11 — 11 <sup>1</sup> / <sub>2</sub>	11 — 11 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub>
26,986	Do. do. 5 p. c. Cum. Preferred	7 <sup>1</sup> / <sub>2</sub>	6 <sup>3</sup> / <sub>4</sub> — 7 <sup>1</sup> / <sub>4</sub>	6 <sup>3</sup> / <sub>4</sub> — 7	7	6 <sup>1</sup> / <sub>16</sub>
26,986	Do. do. 5 p. c. Deferred	7 <sup>1</sup> / <sub>2</sub>	4 <sup>1</sup> / <sub>2</sub> — 5	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>4</sub>	5	4 <sup>3</sup> / <sub>8</sub>
200,000	Do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106	...	...
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 — 104	101 — 104	...	...
88,321	West India and Panama Telegraph, Limited	10	3 <sup>1</sup> / <sub>2</sub> — 3 <sup>3</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub> — 3 <sup>3</sup> / <sub>4</sub>	3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>4</sub>
34,563	Do. do. 6 p. c. 1st Preference	10	11 <sup>1</sup> / <sub>2</sub> — 12	11 <sup>1</sup> / <sub>2</sub> — 12	...	...
4,669	Do. do. 6 p. c. 2nd Preference	10	13 <sup>1</sup> / <sub>2</sub> — 14	14 — 15	...	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	122 — 127	122 — 127	...	...
179,300	Do. do. 6 p. c. Sterling Bonds	100	97 — 99	99 — 103	...	...
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	1 <sup>3</sup> / <sub>8</sub>	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6<sup>1</sup>/<sub>2</sub> paid), 7<sup>1</sup>/<sub>2</sub>—7<sup>3</sup>/<sub>4</sub>.—Elmore Copper Depositing Priorities, 7 — 7<sup>1</sup>/<sub>2</sub>.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 2<sup>1</sup>/<sub>2</sub>—2<sup>3</sup>/<sub>4</sub>.—House-to-House Company (£5 paid), 5 — 5<sup>1</sup>/<sub>2</sub>.—International Okonite, Ordinary of £10 (£7 paid), 6<sup>1</sup>/<sub>2</sub>—7<sup>1</sup>/<sub>4</sub>.—London Electric Supply Corporation, Ordinary (£5 paid) 2<sup>1</sup>/<sub>2</sub>—3. —Manchester Edison and Swan Company, £9 (£1 paid) 11/- — 13/-.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

# THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 332.)

IN the next number of "Silliman's Journal" (April, 1831), Prof. Henry gave "an account of a large electro-magnet, made for the laboratory of Yale College." The core of the armature weighed 59½ lbs., it was forged under Henry's own direction, and wound by Dr. Ten Eyck. This magnet, wound with 26 strands of copper bell wire of total length of 728 feet, and excited by two cells which exposed nearly 4½ square feet of surface, readily supported on its armature, which weighed 23 lbs., a load of 2,063 lbs.

Writing in 1867 of his earlier experiments, Henry speaks † thus of his ideas respecting the use of additional coils on the magnet and the increase of battery power:—

"To test these principles on a larger scale, the experimental magnet was constructed, which is shown in fig. 6. In this a

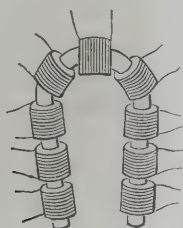


FIG. 6.—HENRY'S EXPERIMENTAL ELECTRO-MAGNET.

number of compound helices was placed on the same bar, their ends left projecting, and so numbered that they could all be united into one long helix, or variously combined in sets of lesser length.

"From a series of experiments with this and other magnets, it was proved that in order to produce the greatest amount of magnetism from a battery of a single cup a number of helices is required; but when a compound battery is used, then one long wire must be employed, making many turns around the iron, the length of wire, and consequently the number of turns, being commensurate with the projectile power of the battery.

"In describing the results of my experiments, the terms 'intensity' and 'quantity' magnets were introduced to avoid circumlocution, and were intended to be used merely in a technical sense. By the intensity magnet I designated a piece of soft iron, so surrounded with wire that its magnetic power could be called into operation by an intensity battery; and by a quantity magnet, a piece of iron so surrounded by a number of separate coils, that its magnetism could be fully developed by a quantity battery.

"I was the first to point out this connection of the two kinds of the battery with the two forms of the magnet; in my paper, in 'Silliman's Journal,' January, 1831, and clearly to state that when magnetism was to be developed by means of a compound battery, one long coil must be employed, and when the maximum effect was to be produced by a single battery, a number of single strands should be used. . . . Neither the electro-magnet of Sturgeon nor any electro-magnet ever made previous to my investigations was applicable to transmitting power to a distance. . . . The electro-magnet made by Sturgeon, and copied by Dana, of New York, was an imperfect quantity magnet, the feeble power of which was developed by a single battery."

Finally, Henry ‡ sums up his own position as follows:—

"1. Previous to my investigations, the means of developing magnetism in soft iron were imperfectly understood, and the electro-magnet which then existed was inapplicable to transmissions of power to a distance.

"2. I was the first to prove by actual experiment that in order to develop magnetic power at a distance, a galvanic battery of 'intensity' must be employed to project the current through the long conductor, and that a magnet surrounded by many turns of one long wire must be used to receive this current.

"3. I was the first to actually magnetise a piece of iron at a distance, and to call attention to the fact of the applicability of my experiments to the telegraph.

"4. I was the first to actually sound a bell at a distance by means of the electro-magnet.

"5. The principles I have developed were applied by Dr. Gale to render Morse's machine effective at a distance."

Though Henry's researches were published in 1831, they were for some years almost unknown in Europe. Until April, 1837, when Henry himself visited Wheatstone at his laboratory at King's College, the latter did not know how to construct an electro-magnet that could be worked through a long wire circuit. Cooke, who became the coadjutor of Wheatstone, had originally

come to him to consult him,\* in February, 1837, about his telegraph and alarm, the electro-magnets of which, though they worked well on short circuits, refused to work when placed in circuit with even a single mile of wire. Wheatstone's own account† of the matter is extremely explicit:—"Relying on my former experience, I at once told Mr. Cooke that his plan would not and could not act as a telegraph, because sufficient attractive power could not be imparted to an electro-magnet interposed in a long circuit; and to convince him of the truth of this assertion, I invited him to King's College to see the repetition of the experiments on which my conclusion was founded. He came, and after seeing a variety of voltaic magnets, which, even with powerful batteries, exhibited only slight adhesive attraction, he expressed his disappointment."

After Henry's visit to Wheatstone, the latter altered his tone. He had been using, *faute de mieux*, relay circuits to work the electro-magnets of his alarm in a short circuit with a local battery. "These short circuits," he writes, "have lost nearly all their importance, and are scarcely worth contending about since my discovery" (the italics are our own) "that electro-magnets may be so constructed as to produce the required effects by means of the direct current, even in very long circuits."‡

We pass on to the researches of the distinguished physicist of Manchester, whose decease we have lately had to deplore, Mr. J. P. Joule, who, fired by the work of Sturgeon, made most valuable contributions to the subject. Most of these were published either in Sturgeon's "Annals of Electricity," or in the "Proceedings of the Literary and Philosophical Society of Manchester," but their most accessible form is the republished volume issued five years ago by the Physical Society of London.

In his earliest investigations he was endeavouring to work out the details of an electric motor. The following is an extract from his own account ("Reprint of Scientific Papers," p. 7.):—

"In the further prosecution of my enquiries, I took six pieces of round bar iron of different diameters and lengths, also a hollow cylinder, ⅛th of an inch thick in the metal. These were bent in the U-form, so that the shortest distance between the poles of each was half an inch; each was then wound with 10 feet of covered copper wire, ⅛th of an inch in diameter. Their attractive powers under like currents for a straight steel magnet, 1½ inch long, suspended horizontally to the beam of a balance, were, at the distance of half an inch, as follows:—

	No. 1. Hollow.	No. 2. Solid.	No. 3. Solid.	No. 4. Solid.	No. 5. Solid.	No. 6. Solid.	No. 7. Solid.
Length round the bend in inches. . . . .	6	5½	2½	5½	2½	5½	2½
Diameter in inches . . .	½	½	½	¾	¾	¾	¾
Attraction for steel mag- net, in grains. . . . .	7.5	6.3	5.1	5.0	4.1	4.8	3.6
Weight lifted, in ounces	36	52	92	36	52	20	28

"A steel magnet gave an attractive power of 23 grains, while its lifting power was not greater than 60 ounces.

"The above results will not appear surprising if we consider, first, the resistance which iron presents to the induction of magnetism, and, second, how very much the induction is exalted by the completion of the magnetic circuit.

"Nothing can be more striking than the difference between the ratios of lifting to attractive power at a distance in the different magnets. Whilst the steel magnet attracts with a force of 23 grains and lifts 60 ounces, the electro-magnet No. 3 attracts with a force of only 5.1 grains, but lifts as much as 92 ounces.

"To make a good electro-magnet for lifting purposes:—1. Its iron, if of considerable bulk, should be compound, of good quality, and well annealed. 2. The bulk of the iron should bear a much greater ratio to its length than is generally the case. 3. The poles should be ground quite true, and fit flatly and accurately to the armature. 4. The armature should be equal in thickness to the iron of the magnet.

"In studying what form of electro-magnet is best for attraction from a distance, two things must be considered, viz., the length of the iron, and its sectional area.

"Now I have always found it disadvantageous to increase the length beyond what is needful for the winding of the covered wire."

These results were announced in March, 1839. In May of the same year Joule propounded a law of the mutual attraction of two electro-magnets as follows:—"The attractive force of two electro-magnets for one another is directly proportional to the square of the electric force to which the iron is exposed; or if  $E$  denote the electric current,  $w$  the length of wire, and  $m$  the magnetic attraction,  $m = E^2 w^2$ ." The discrepancies which he himself observed he rightly attributed to the iron becoming saturated magnetically. In March, 1840, he extended this same law to the lifting power of the horseshoe electro-magnet.

In August, 1840, he wrote to the "Annals of Electricity" on electro-magnetic forces, dealing chiefly with some special electro-magnets for traction. One of these possessed the form shown in

\* Cantor Lecture. Delivered before the Society of Arts, January 20th, 1890.

† Statement in Relation to the History of the Electro-Magnetic Telegraph: from the Smithsonian Annual Report for 1857, p. 99.

‡ "Scientific Writings of Joseph Henry," vol. ii., p. 435.

\* See Mr. Latimer Clark's account of Cooke in vol. viii. of "Journal of Society of Telegraph Engineers, p. 3,741, 1880.

† W. F. Cooke, "The Electric Telegraph: was it invented by Prof. Wheatstone?" 1856-7, pt. ii., p. 87.

‡ *Id.*, p. 95.

Fig. 7. Both the magnet and the iron keeper were furnished with eye-holes for the purpose of suspension and measurement of the force requisite to detach the keeper. Joule thus writes about the experiments \* :—

"I proceed now to describe my electro-magnets, which I constructed of very different sizes, in order to develop any curious circumstance which might present itself. A piece of cylindrical wrought iron, eight inches long, had a hole one inch in diameter, bored the whole length of its axis; one side was planed until the hole was exposed sufficiently to separate the thus formed poles one-third of an inch. Another piece of iron, also eight inches long, was then planed, and being secured with its face in contact with the other planed surface, the whole was turned into a cylinder eight inches long, three and three-quarter inches in exterior, and one inch interior diameter. The larger piece was then covered with calico and wound with four copper wires covered with silk, each 23 feet long, and  $\frac{1}{16}$ th of an inch in diameter—a quantity just sufficient to hide the exterior surface, and to fill the interior opened hole." . . . . . "The above is designated No. 1, and the rest are numbered in the order of their description.

"I made No. 2 of a bar of half-inch round iron 2·7 inches long. It was bent into an almost semi-circular shape, and then covered with seven feet of insulated copper wire  $\frac{1}{16}$ th of an inch thick. The poles are half an inch asunder, and the wire completely fills the space between them.

"A third electro-magnet was made of a piece of iron 0·7 inch long, 0·37 inch broad, and 0·15 inch thick. Its edges were reduced to such an extent that the transverse section was elliptical. It was bent into a semi-circular shape, and wound with 19 inches of silked copper wire,  $\frac{1}{16}$ th of an inch in diameter.

"To procure a still more extensive variety, I constructed what might, from its extreme minuteness, be termed an *elementary electro-magnet*. It is the smallest, I believe, ever made, consisting of a bit of iron wire  $\frac{1}{4}$  of an inch long, and  $\frac{1}{16}$ th of an inch in diameter. It was bent into the shape of a semi-circle, and was wound with three turns of *uninsulated* copper wire  $\frac{1}{16}$ th of an inch in thickness."

With these magnets experiments were made with various strengths of currents, the tractive forces being measured by an arrangement of levers. The results, briefly, are as follows :— Electro-magnet No. 1, the iron of which weighed 15 lbs., required a weight of 2,090 lbs. to detach the keeper. No. 2, the iron of which weighed 1,057 grains, required 49 lbs. to detach its armature. No. 3, the iron of which weighed 65·3 grains, supported a load of 12 lbs., or 1,286 times its own weight. No. 4, the weight of which was only half a grain, carried in one instance 1,417 grains, or 2,834 times its own weight.

"It required much patience to work with an arrangement so minute as this last; and it is probable that I might ultimately have obtained a larger figure than the above, which, however, exhibits a power proportioned to its weight far greater than any on record, and is eleven times that of the celebrated steel magnet which belonged to Sir Isaac Newton.

"It is well known that a steel magnet ought to have a much greater length than breadth or thickness; and Mr. Scoresby has found that when a large number of straight steel magnets are bundled together, the power of each when separated and examined is greatly deteriorated. All this is easily understood, and finds its cause in the attempt of each part of the system to induce upon the other part a contrary magnetism to its own. Still there is no reason why the principle should in all cases be extended from the steel to the electro-magnet, since in the latter case a great and commanding inductive power is brought into play to sustain what the former has to support by its own unassisted retentive property. All the preceding experiments support this position, and the following table gives proof of the obvious and necessary general consequence, the maximum power of the electro-magnet is directly proportional to its least transverse sectional area. The second column of the Table contains the least sectional area in square inches of the entire magnetic circuit. The maximum power in pounds avoirdupois is recorded in the third; and this, reduced to an inch square of sectional area, is given in the fourth column under the title of specific power."

TABLE I.

Description.	Least Sectional Area.	Maximum Power.	Specific Power.
My own electro-magnets	No. 1. . . . .	10	2090
	No. 2. . . . .	0·196	49
	No. 3. . . . .	0·0436	12
	No. 4. . . . .	0·0012	0 202
Mr. J. C. Nesbit's. Length round the curve, 3 feet; diameter of iron core, 2 $\frac{3}{4}$ in.; sectional area, 5·7 in.; do. of armature, 4·5 in.; weight of iron, about 50 lbs. . . . .	4·5	1428	317
Prof. Henry's. Length round the curve, 20 in.; section, 2 in. square; sharp edges rounded off; weight, 21 lbs. . . . .	3·94	750	190
Mr. Sturgeon's original. Length round the curve, about 1 ft.; diameter of the round bar, $\frac{1}{2}$ in. . . . .	0·196	50	255

\* "Scientific Papers," vol. i., p. 30.

"The above examples are, I think, sufficient to prove the rule I have advanced. No. 1 was probably not fully saturated; otherwise I have no doubt that its power per square inch would have approached 300. Also the specific power of No. 4 is small, because of the difficulty of making a good experiment with it."

These experiments were followed by some to ascertain the effect of the length of the iron of the magnet, which he considered, at least in those cases where the degree of magnetisation is considerably below the point of saturation, to offer a decidedly proportional resistance to magnetisation; a view the justice of which is now after 50 years amply confirmed.

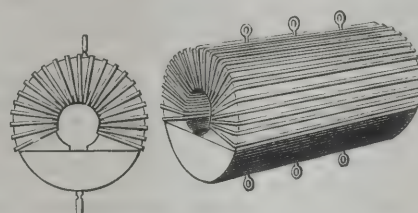


FIG. 7.—Joule's ELECTRO-MAGNET.

In November of the same year further experiments\* in the same direction were published. A tube of iron, spirally made and welded, was prepared, planed down as in the preceding case, and fitted to a similarly prepared armature. The hollow cylinder thus formed, shown in fig. 8, was 2 feet in length, its internal

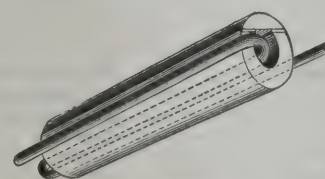


FIG. 8.—Joule's CYLINDRICAL ELECTRO-MAGNET.

diameter was 1·42 inch, its internal being 0·5 inch. The least sectional area was 10 $\frac{1}{2}$  square inches. The exciting coil consisted of a single copper rod, covered with tape, bent into a sort of S-shape. This was later replaced by a coil of 21 copper wires, each  $\frac{1}{16}$ th inch in diameter and 23 feet long, bound together by cotton tape. This magnet, excited by a battery of 16 of Sturgeon's cast-iron cells, each one foot square and one and a-half inch in interior width, arranged in a series of four, gave a lifting power of 2,775 lbs.

Joule's work was well worthy of the master from whom he had learned his first lesson in electro-magnetism. He showed his devotion not only by writing descriptions of them for Sturgeon's "Annals," but by exhibiting two of his electro-magnets at the Victoria Gallery of Practical Science, of which Sturgeon was director. Others, stimulated into activity by Joule's example, proposed new forms, amongst them being two Manchester gentlemen, Mr. Radford and Mr. Richard Roberts, the latter being a well-known engineer and inventor. Mr. Radford's electro-magnet consisted of a flat iron disc, with deep spiral grooves cut in its face, in which were laid the insulated copper wires. The armature consisted of a plain iron disc of similar size. This form is described in Vol. IV. of Sturgeons "Annals." Mr. Roberts's form

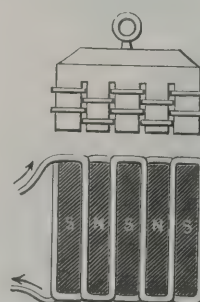


FIG. 9.—ROBERTS'S ELECTRO-MAGNET.

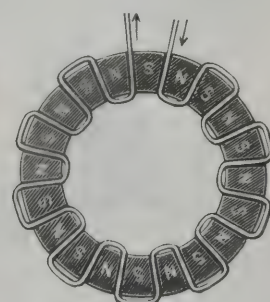


FIG. 10.—Joule's ZIG-ZAG ELECTRO-MAGNET.

of electro-magnet consisted of a rectangular iron block, having straight parallel grooves cut across its face, as in Fig. 9. This was described in Vol. VI. of Sturgeon's "Annals," p. 166. Its face was 6 $\frac{3}{4}$ ths inches square, and its thickness 2 $\frac{1}{10}$ ths inch. It weighed, with the conducting wire, 35 lbs.; and the armature, of the same size and 1 $\frac{1}{2}$  inch thick, weighed 23 lbs. The load sustained by this magnet was no less than 2,950 lbs. Roberts

\* "Scientific Papers," p. 40, and "Annals of Electricity," vol. v., p. 170.

inferred that a magnet, if made of equal thickness, but five feet square, would sustain 100 tons' weight. Some of Roberts's apparatus is still preserved in the Museum of Peel Park, Manchester.

On p. 431 of the same volume of the "Annals," Joule described yet another form of electro-magnet, the form of which resembled in general fig. 10; but which, in actual fact, was built up of 24 separate flat pieces of iron bolted to a circular brass ring. The armature was a similar structure, but not wound with iron. The iron of the magnet weighed 7 lbs., and that of the armature 4.55 lbs. The weight was 2,710 lbs., when excited by 16 of Sturgeon's cast iron cells.

In a subsequent paper on the calorific effects of magneto-electricity,\* published in 1843, Joule described another form of electro-magnet of horseshoe shape, made from a piece of boiler-plate. This was not intended to give great lifting power, and was used as the field magnet of a motor. In 1852, another powerful electro-magnet of horseshoe form, somewhat similar to the preceding, was constructed by Joule for experiment. He came to the conclusion † that, owing to magnetic saturation setting in, it was improbable that any force of electric current could give a magnetic attraction greater than 200 lbs. per square inch. "That is, the greatest weight which could be lifted by an electro-magnet formed of a bar of iron one inch square, bent into a semi-circular shape, would not exceed 400 lbs."

With the researches of Joule may be said to end the first stage of development. The notion of the magnetic circuit which had thus guided Joule's work did not commend itself at that time to the professors of physical theories; and the practical men, the telegraph engineers, were for the most part content to work by purely empirical methods. Between the practical man and the theoretical man there was, at least on this topic, a great gulf fixed. The theoretical man, arguing as though magnetism consisted in a surface distribution of polarity, and as though the laws of electro-magnets were like those of steel magnets, laid down rules not applicable to the cases which occur in practice, and which hindered rather than helped progress. The practical man, finding no help from theory, threw it on one side as misleading and useless. It is true that a few workers made careful observations and formulated into rules the results of their investigations. Amongst these, the principal were Ritchie, Robinson, Müller, Dub, Von Kolke, and Du Moncel; but their work was little known beyond the pages of the scientific journals wherein their results were described. Some of these results will be examined in my later lectures, but they cannot be discussed in this historical *résumé*, which is accordingly closed.

#### GENERALITIES CONCERNING ELECTRO-MAGNETS.

**Materials.**—In any complete treatise on the electro-magnet, it would be needful to enumerate, and to discuss in detail, the several constructive features of the apparatus. Three classes of material enter into its construction—first, the iron which constitutes the material of the magnetic circuit, including the armature as well as the cores on which the coils are wound, and the yoke that connects them; secondly, the copper which is employed as the material which conducts the electric currents, and which is usually in the form of wire; thirdly, the insulating material employed to prevent the copper coils from coming into contact with one another, or with the iron core. There is a further subject for discussion in the bobbins, formers, or frames upon which the coils are in so many cases wound, and which may in some cases be made in metal, but often are not. The engineering of the electro-magnet might well furnish matter for a special chapter.

#### TYPICAL FORMS.

It is difficult to devise a satisfactory or exhaustive classification of the varied forms which the electro-magnet has assumed; but it is at least possible to enumerate some of the typical forms.

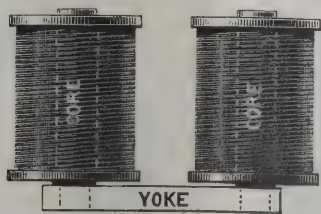


FIG. 11.—TYPICAL TWO-POLE ELECTRO-MAGNET.

1. **Bar Electro-magnet.**—This consists of a single straight core (whether solid, tubular, or laminated), surrounded by a coil. Fig. 3 (ELECTRICAL REVIEW, September 19th, p. 329) depicted Sturgeon's earliest example.

2. **Horseshoe Electro-magnet.**—There are two sub-types included in this name. The original electro-magnet of Sturgeon (fig. 1, p. 329) really resembled a horseshoe in form, being constructed of a single piece of round wrought iron, about half an inch in

diameter, and nearly a foot long, bent into an arch. In recent years the other sub-type has prevailed, consisting, as shown in Fig. 11, of two separate iron cores, usually cut from circular rod, fixed into a third piece of wrought-iron, the yoke. Occasionally this form is modified by the use of one coil only, the second core being left uncovered. This form has received in France the name of *aimant boîteux*. Its merits will be considered later. Sometimes a single coil is wound upon the yoke, the two limbs being uncovered.

3. **Ironclad Electro-magnet.**—This form, which has many times been re-invented, differs from the simple bar magnet in having an iron shell or casing external to the coils, and attached to the core at one end. Such a magnet presents, as depicted in Fig. 12, a

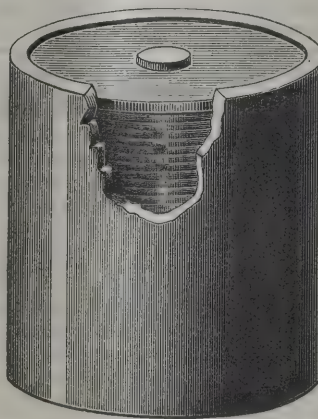


FIG. 12.—IRON-CLAD ELECTRO-MAGNET.

central pole at one end surrounded by an outer annular pole of the opposite polarity. The appropriate armature for electro-magnets of this type is a circular disc or lid of iron.

4. **Coil and Plunger.**—A detached iron core is attracted into a hollow coil, or solenoid, of copper wire, when a current of electricity flows round the latter. This is a special form, and will receive extended consideration.

5. **Special Forms.**—Beside the leading forms enumerated above, there are a number of special types, multipolar, spiral, and others designed for particular purposes. There is also a group of forms intermediate between the ordinary electro-magnet and the coil and plunger form.

#### POLARITY.

It is a familiar fact that the polarity of an electro-magnet depends upon the sense in which the current is flowing around it. Various rules for remembering the relation of the electric flow

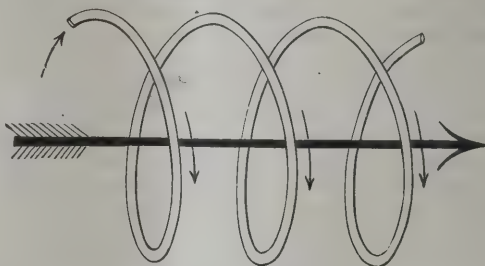


FIG. 13.—DIAGRAM ILLUSTRATING RELATION OF MAGNETISING CIRCUIT AND RESULTING MAGNETIC FORCE.

and the magnetic force have been given. One of them that is useful is that when one is looking at the north pole of an electro-magnet, the current will be flowing around that pole in the sense opposite to that in which the hands of a clock are seen to revolve. Another useful rule, suggested by Maxwell, is illustrated by fig. 13, namely, that the sense of the circulation of the current (whether right or left-handed), and the positive direction of the resulting magnetic force are related together in the same way as the rotation and the travel of a right-handed screw are associated together. Right-handed rotation of the screw is associated with forward travel. Right-handed circulation of a current is associated with a magnetic force tending to produce north polarity at the forward end of the core.

#### USES IN GENERAL.

Regarded as a piece of mechanism, an electro-magnet may be regarded as an apparatus for producing a mechanical action at a place distant from the operator who controls it; the means of communication from the operator to the distant point where the electro-magnet is being the electric wire. The uses of electro-magnets may, however, be divided into two main divisions. For certain purposes an electro-magnet is required merely for obtain-

\* "Scientific Papers," vol. i., p. 123; and "Phil. Mag.," Ser. 3, vol. xxiii., p. 263, 1843.

† "Scientific Papers," vol. i., p. 362; and "Phil. Mag.," Ser. 4, vol. iii., p. 32.

ing temporary adhesion or lifting power. It attaches itself to an armature, and cannot be detached so long as the exciting current is maintained, except by the application of a superior opposing pull. The force which an electro-magnet thus exerts upon an armature of iron, with which it is in direct contact, is always considerably greater than the force with which it can act on an armature at some distance away, and the two cases must be carefully distinguished. *Traction* of an armature in contact, and *attraction* of an armature at a distance, are two different functions. So different, indeed, that it is no exaggeration to say that an electro-magnet designed for the one purpose is unfitted for the other. The question of designing electro-magnets for either of these purposes will occupy a large part of these lectures. The action which an electromagnet exercises on an armature in its neighbourhood may be of several kinds. If the armature is of soft iron, placed nearly parallel to the polar surfaces, the action is one simply of attraction, producing a motion of pure translation, irrespective of the polarity of the magnet. If the armature lies oblique to the line of the poles there will be a tendency to turn it round, as well as to attract it; but, again, if the armature is of soft iron the action will be independent of the polarity of the magnet, that is to say, independent of the direction of the exciting current. If, however, the armature be itself a magnet of steel permanently magnetised, then the direction in which it tends to run, and the amount, or even the sign of the force with which it is attracted, will depend on the polarity of the electro-magnet, that is to say, will depend on the direction in which the exciting current circulates. Hence there arises a difference between the operation of a *non-polarised* and that of a *polarised* apparatus, the latter term being applied to those forms in which there is employed a portion—say an armature—to which an initial fixed magnetisation has been imparted. Non-polarised apparatus is in all cases independent of the direction of the current. Another class of uses served by electro-magnets is the production of rapid vibrations. These are employed in the mechanism of electric trembling bells, in the automatic breaks of induction coils, in electrically-driven tuning-forks such as are employed for chronographic purposes, and in the instruments used in harmonic telegraphy. Special constructions of electro-magnet are appropriate to special purposes such as these. The adaptation of electro-magnets for the special end of responding to rapidly alternating currents is a closely kindred matter. Lastly, there are certain applications of the electro-magnet, notably in the construction of some forms of arc lamp, for which it is specially sought to obtain an equal, or approximately equal, pull over a definite range of motion. This use necessitates special designs.

#### THE PROPERTIES OF IRON.

A knowledge of the magnetic properties of iron of different kinds is absolutely fundamental to the theory and design of electro-magnets. No excuse is, therefore, necessary for treating this matter with some fullness. In all modern treatises of magnetism, the usual terms are defined and explained. Magnetism which was formerly treated of as though it were something distributed over the end-surfaces of magnets, is now known to be a phenomenon of internal structure; and the appropriate mode of considering it is to treat the magnetic materials, iron and the like, as being capable of acting as good conductors of the magnetic lines—in other words, as possessing magnetic *permeability*. The precise notion now attached to this word is that of a numerical coefficient. Suppose a magnetic force—due, let us say, to the circulation of an electric current in a surrounding coil—were to act on a space occupied by air, there would result a certain number of magnetic lines in that space. In fact, the intensity of the magnetic force, symbolised by the letter  $H$ , is often expressed by saying that it would produce  $H$  magnetic lines per square centimetre in air. Now, owing to the superior magnetic power of iron, if the space subjected to this magnetic force were filled with iron instead of air, there would be produced a larger number of magnetic lines per square centimetre. This larger number in the iron expresses the degree of magnetisation in the iron; it is symbolised\* by the letter  $B$ . The ratio of  $B$  to  $H$  expresses the permeability of the material. The usual symbol for permeability is the Greek letter  $\mu$ . So we may say that  $B$  is equal to  $\mu$  times  $H$ . For example, a certain specimen of iron, when subjected to a magnetic force capable of creating, in air, 50 magnetic lines to the square centimetre, was found to be permeated by no fewer than 16,062 mag-

netic lines per square centimetre. Dividing the latter figure by the former gives us the value of the permeability at this stage of the magnetisation 321, or the permeability of the iron is 321 times that of air. The permeability of such non-magnetic materials as silk, cotton, and other insulators, also of brass, copper, and all the non-magnetic metals, is taken as 1, being practically the same as that of the air.

This mode of expressing the fact is, however, complicated by the fact of the tendency in all kinds of iron to magnetic saturation. In all kinds of iron the magnetisability of the material becomes diminished as the actual magnetisation is pushed further. In other words, when a piece of iron has been magnetised up to a certain degree it becomes, from that degree onward, less permeable to further magnetisation, and, though actual saturation is never reached, there is a practical limit beyond which the magnetisation cannot well be pushed. Joule was one of the first to establish this tendency toward magnetic saturation. Modern researches have shown numerically how the permeability diminishes as the magnetisation is pushed to higher stages. The practical limit of the magnetisation,  $B$ , in good wrought iron is about 20,000 magnetic lines to the square centimetre, or about 125,000 lines to the square inch; and, in cast iron, the practical saturation limit is nearly 12,000 lines per square centimetre, or about 70,000 lines per square inch. In designing electro-magnets, before calculations can be made as to the size of a piece of iron required for the core of a magnet for any particular purpose, it is necessary to know the magnetic properties of that piece of iron; for it is obvious that if the iron be of inferior magnetic permeability, a larger piece of it will be required in order to produce the same magnetic effect as might be produced with a smaller piece of higher permeability. Or, again, the piece having inferior permeability will require to have more copper wire wound on it; for in order to bring up its magnetisation to the required point, it must be subjected to higher magnetising forces than would be necessary if a piece of higher permeability had been selected.

A convenient mode of studying the magnetic facts respecting any particular brand of iron is to plot on a diagram the curve of magnetisation—i.e., the curve in which the values, plotted horizontally, represent the magnetic force,  $H$ , and the values plotted vertically those that correspond to the respective magnetisation,  $B$ . In fig. 14, which is modified from the researches of Prof. Ewing, are given five curves relating to soft iron, hardened iron, annealed steel, hard-drawn steel, and glass-hard steel. It will be noticed that all these curves have the same general form. For small values of  $H$  the values of  $B$  are small, and as  $H$  is increased  $B$  increases also. Further, the curve rises very suddenly, at least with all the softer sorts of iron, and then bends over and becomes nearly horizontal. When the magnetisation is in the stage below the bend of the curve, the iron is said to be far from the state of saturation. But when the magnetisation has been pushed beyond

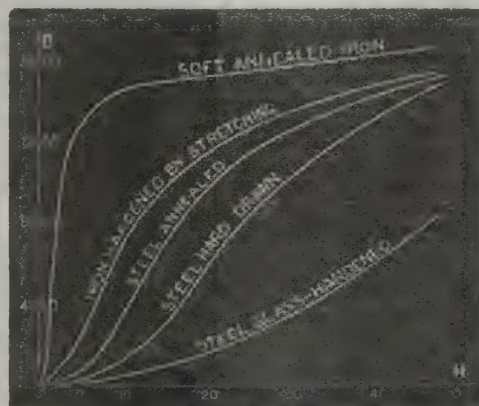


FIG. 14.—CURVES OF MAGNETISATION OF DIFFERENT  
MAGNETIC MATERIALS.

the bend of the curve, the iron is said to be in the stage approaching saturation; because at this stage of magnetisation it requires a large increase in the magnetising force to produce even a very small increase in the magnetisation. It will be noted that for soft wrought iron the stage of approaching saturation sets in when  $B$  has attained the value of about 16,000 lines per square centimetre, or when  $H$  has been raised to the value of about 50. As we shall see, it is not economical to push  $B$  beyond this limit; or, in other words, it does not pay to use stronger magnetic forces than those of about  $H = 50$ .

#### METHODS OF MEASURING PERMEABILITY.

There are four sorts of experimental methods of measuring permeability.

1. *Magnetometric Methods*.—These are due to Müller, and consist in surrounding a bar of the iron in question by a magnetising coil, and observing the deflection its magnetisation produces in a magnetometer.

2. *Balance Methods*.—These methods are a variety of the preceding, a compensating magnet being employed to balance the effect produced by the magnetised iron on the magnetometric needle. Von Feilitzsch used this method, and it has received a

\* The following are the various ways of expressing the three quantities under consideration:—

- $B$ —The internal magnetisation.  
The magnetic induction.  
The induction.  
The intensity of the induction.  
The permeation.  
The number of lines per square centimetre in the material.
- $H$ —The magnetising force at a point.  
The magnetic force at a point.  
The intensity of the magnetic force.  
The number of lines per square centimetre that there would be in air.
- $\mu$ —The magnetic permeability.  
The permeability.  
The specific conductivity for magnetic lines.  
The magnetic multiplying power of the material.

more definite application in the magnetic balance of Prof. Hughes. The actual balance is exhibited to-night upon the table, and I have beside me a large number of observations made by students of the Technical College by its means, upon sundry samples of iron and steel. None of these methods are, however, to be compared with those that follow.

3. *Inductive Methods.*—There are several varieties of these, but all depend on the generation of a transient induction current in an exploring coil which surrounds the specimen of iron, the integral current being proportional to the number of magnetic lines introduced into, or withdrawn from, the circuit of the exploring coil. Three varieties may be mentioned.

(A) *Ring Method.*—In this method, due to Kirchhoff, the iron under examination is made up into a ring, which is wound with a primary, or exciting coil, and with a secondary, or exploring coil. Determinations on this plan have been made by Stowletow, Rowland, Bosanquet, and Ewing; also by Hopkinson. Rowland's arrangement of the experiment is shown in fig. 15, in which B is the exciting battery; S, the switch for turning on or reversing the current; R, an adjustable resistance; A, an ampère-metre; and BG the ballistic galvanometer, the first swing of which measures the integral induced current. RC is an earth conductor or reversing coil wherewith to calibrate the readings of the galvanometer, and above is an arrangement of a coil and a magnet to assist in bringing the swinging needle to

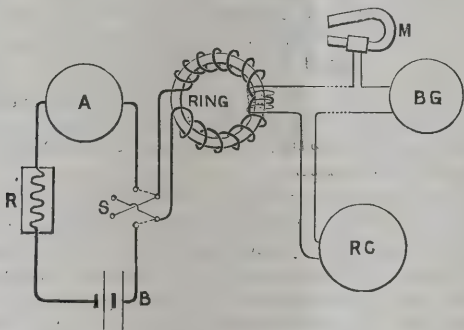


FIG. 15.—RING METHOD OF MEASURING PERMEABILITY (ROWLAND'S ARRANGEMENT).

rest between the observations. The exciting coil and the exploring coil are both wound upon the ring; the former is distinguished by being drawn with a thicker line. The usual mode of procedure is to begin with a feeble exciting current, which is suddenly reversed, and then reversed back. The current is then increased, reversed, and re-reversed; and so on, until the strongest available points are reached. The values of the magnetising force, *H*, are calculated from the observed value of the current by the following rule. If the strength of the current, as measured by the ampère-meter be *i*, the number of spires of the exciting coil, *s*, and the length, in centimetres, of the coil (i.e., the mean circumference of the ring) be *l*, then *H* is given by the formula—

$$H = \frac{4 \pi}{10} \times \frac{s i}{l} = 1.2566 \times \frac{s i}{l}.$$

Bosanquet, applying this method to a number of iron rings, obtained some important results. In fig. 16 are plotted out the values of *H* and *B* for seven rings. One of these, marked J, was of cast steel, and was examined both when soft and afterwards when hardened. Another, marked I, was of the best Lowmoor iron. Five were of Crown iron, of different sizes. They were marked for distinction with the letters G, E, F, H, K. In the accompanying Table are set down the values of *B* at different stages of the magnetisation.

TABLE OF VALUES OF *B* IN FIVE CROWN IRON RINGS.

Name.	G.	E.	F.	H.	K.
Mean diam. bar thickness.	91.5 cm. 2.535	10.085 cm. 1.298	22.1 cm. 1.292	10.735 cm. 0.7187	22.725 cm. 0.7544
Magnetising force.					
0.2	126	73	62	82	85
0.5	377	270	224	208	214
1	1,449	1,293	840	675	885
2	4,564	3,952	3,533	2,777	2,417
5	9,900	9,147	8,293	8,479	8,884
10	13,023	13,367	12,540	11,376	11,388
20	14,911	14,653	14,710	14,066	13,273
50	16,217	15,704	16,062	15,174	13,890
100	17,148	16,677	17,900	16,134	14,837

I have the means here of illustrating the induction method of measuring permeability. Here is an iron ring, having a cross-section of almost exactly one square centimetre. It is wound with an exciting coil supplied with current by two accumulator cells; over it is also wound an exploring coil of 100 turns connected in

circuit (as in Rowland's arrangement) with a ballistic galvanometer which reflects a spot of light on the screen. In the circuit of the galvanometer is also included a reversing earth-coil. As a matter of fact, this earth-coil is of such a size, and wound with so many convolutions of wire that, when it is turned over, the amount of cutting of magnetic lines is equal to 840,000, or is the same as if 840,000 magnetic lines had been cut once. By adjusting the resistance of the galvanometer circuit, it is arranged that the first swing due to the induced current, when I suddenly turn over the earth coil, is 8.4 scale divisions. Then, seeing that our exploring coil has 100 turns, it follows that, when in our subsequent experiment with the ring, we get an induced current from it, each division of the scale over which the spot swings will mean 1,000 lines in the iron. I turn on my exciting current. See: it swings about 11 divisions. On breaking the circuit, it swings nearly 11 divisions the other way. That means that the magnetising force carries the magnetisation of the iron up to 11,000 lines; or, as the cross-section is about 1 square centimetre, *B* = 11,000. Now, how much is *H*? The exciting coil has 180 windings, and the exciting current through the ampèremeter is just 1 ampère. The total excitation is just 180 "ampère-turns." We must, according to our rule given above, multiply this by 1.2566 and divide by the mean circumferential length of the coil, which is about 32 centimetres. This makes *H* = 7. So if *B* = 11,000 and *H* = 7, the permeability (which is the ratio of them) is about 1,570. It is a rough and hasty experiment, but it illustrates the method.

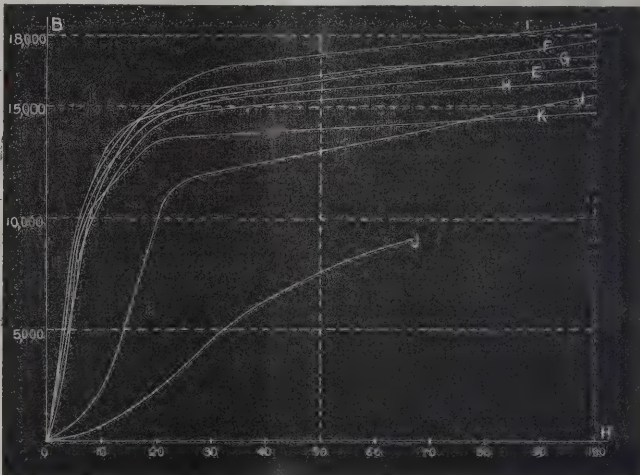


FIG. 16.—BOSANQUET'S DATA OF MAGNETIC PROPERTIES OF IRON AND STEEL RINGS.

Bosanquet's experiments settle the debated question whether the outer layers of an iron core shield the inner layers from the influence of magnetising forces. Were this the case, the rings made from thin bar iron should exhibit higher values of *B* than do the thicker rings. This is not so; for the thickest ring, G, shows throughout the highest magnetisations.

(B.) *Bar Method.*—This method consists in employing a long bar of iron instead of a ring. It is covered from end to end with the exciting coil, but the exploring coil consists of but a few turns of wire situated just over the middle part of the bar. Rowland, Bosanquet, and Ewing have all employed this variety of method; and Ewing specially used bars the length of which was more than 100 times their diameter, in order to get rid of errors arising from end-effects.

(To be continued.)

### ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

11426. "Improvements in the mode of driving, by means of electric motors, tramcars and other vehicles, and in apparatus for reducing in transmission to the axles of such vehicles the speed of rotation derived from electric and other motors." P. A. NEWTON. (Communicated from abroad by W. Main, of New York.) Dated July 16. 1s. 6d. Consists, in part, of an improvement upon what is commonly known as Watt's sun and planet gear. 8 claims.

11589. "Improvements in electric conductors, and in laying and supporting conductors within conduits." R. E. B. CROMPTON. Dated July 20. 8d. Relates to further improvements connected with Letters Patent No. 7655 of the 25th May, 1888. 5 claims.

11847. "Improvements in the distribution of electrical energy." SIEMENS BROTHERS & Co. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated July 25. 8d. Claims:—1. The method of distributing electrical energy wherein three or more secondary conductors that supply the groups of consuming apparatus are combined with one or more current

generating machines and one or more transformers in such manner that the current generating machine or machines is or are connected by two main leads to the primary coil of the transformer the secondary coil of which is divided into sections which are connected to the said three or more secondary conductors substantially as described. 2. The modification of the method of distribution referred to in the preceding claim wherein the transformers consist of motor-generators having two or more generator armatures and driven by the current from the main current generator, the generator armatures of the motor transformers being coupled in series and connected to the said three or more secondary conductors substantially as described.

12772. "Improvements in means or apparatus for the generation and conversion of electric energy." A. DE CASTRO. Dated August 13. 8d. Consists in the employment of finely subdivided or comminuted magnetisable metal, usually iron filings, arranged in such way as to be loose or free to move, so that the particles may vibrate, and subjected to the action of magnetic lines of force derived either from permanent or electro-magnets, or from an exciting coil or coils. 4 claims.

12982. "Improvements in actuating mechanism for electrical switches." T. BARTON. Dated August 17. 6d. Claim:—The combination of a pulley or roller working against a lever actuated by a spring or working against a spring only, of special design, without the lever, and applied for the purpose of forcing the contact maker home in both directions, and applied to a switch for making and breaking electric circuits.

13371. "Improvements in electric telegraphic apparatus, applicable also to other electric signalling or indicating apparatus." T. H. PARKER and G. W. FAIRALL. Dated August 24. 8d. Has for its object to automatically relay from a battery the particular current which may be in circuit, whether it be of the positive or negative kind, and further to deflect the needle or actuate any other electrical instruments in a much more sensitive or economical manner than has been previously done. The relay instrument consists of five or more permanent magnets, upon each of which is mounted an electro-magnet, by which induced magnetism is obtained; two of these require to be positive, two negative, and the other either positive or negative, as may be preferred. 3 claims.

13859. "Regulator for electric lighting." E. J. HOUGHTON. Dated September 3. 6d. Claim:—1. The gradual insertion in or withdrawal from a circuit of resistance by means of a solenoid and vessel containing mercury or other conducting fluid.

14162. "Improvements in treating and rectifying or ageing alcohol or alcoholic liquors or the like by electricity." A. DE MERITENS. Dated September 7. 4d. Claim:—In the treatment and rectification or ageing of alcohol or alcoholic liquors and the like by electrical action the employment of a salt such as bi-sulphite of soda for the purpose described.

18018. "Improvements in electro-magnetic brakes for railway and similar vehicles and in means for increasing the adhesion between the wheels and rails." A. J. BOULT. (A communication from E. E. Ries and A. H. Henderson, of America.) Dated November 12. 8d. This invention has reference to a system of electro-magnetic brakes for wheeled vehicles, more especially for railway cars, and the same is combined with and is designed to operate in conjunction with a system of electro-magnetic traction increasing devices, for which letters patent have been obtained of Great Britain, No. 4,280, dated 20th March, 1888. 18 claims.

## THE VALUE OF DETAIL IN THE CARE AND LABOUR OF ELECTRIC LIGHT STATIONS.\*

By A. J. DE CAMP.

IT certainly is a fact apparent to any one who has had the handling of electric light stations, that it is essentially a business of detail. The larger items about the business are very easily handled. They will take care of themselves if they are put in the right direction; but there is an infinite number of small things which very materially affect the successful operation of an electric light station. As an illustration of what I mean by that term, I will say that after considerable reflection and dividing the items worthy of care and attention in the management of the business under fifty heads, all of which have to be kept track of, and all of which are a positive and a direct item of expense or income, I find five items which I have had to class as miscellaneous expenses. These include all those items of expense which have a bearing on the business in general, not chargeable to any one of the particular heads under which I have seen fit to group the business.

I find that the amount involved in miscellaneous items for the last year, in one company, was about \$15,000; the space occupied on the books of the company to cover these small items was twice as much as the whole of the other part of the business. The items there reached from one penny up. There is no doubt but that detail may be carried to such an extent that it becomes burdensome. It may become unprofitable on some particular item, but we can only treat this matter as a whole. In one item of carbons alone the reduction in the expense of the carbon caused after a system was adopted by which they were accounted for on the basis of the inches, there was a saving of nearly 50 per cent. in that item alone.

Another important thing is the matter of discipline, because it is utterly impossible to get the detail part of your business thoroughly carried out unless you have a thorough discipline about your station. The most important item in the whole operation of an electric light station in point of dollars and cents is that of labour, and I do not see but what it will always be the case. I remember there was a time when we thought that sixty lamps on an ordinary circuit was a day's work for a man. Now they trim a hundred lamps more easily than they used to trim sixty, and my own judgment is that in the course of time we will work up so that 150 will be no harder than 100.

A custom of dealing with labour, I think, which requires the accounting of every minute of time for which a man is employed, has a very beneficial effect. I think that alone can be credited with a reduction in the pay-roll of some 25 per cent. A custom has been adopted by me of having a slip furnished to the workman by which he accounts for every hour of service; this gives the man who has charge of him an opportunity of judging for himself whether that man has employed his time properly during the ten hours. In the early history of the business it was the custom of my company to do a great deal of work without charge. That was done for policy sake. The number of men apparently required for the operation of the station was very far in excess of what anybody ever represented it to be or supposed it to be. In looking into it, we found that there were two or three men working here, and two or three there, and three or four somewhere else. What were they doing? Well, they were making changes, shifting the position of lamps—they were doing this, that, and the other thing. Well, we were going to be through with that and let these men go, we thought. But the fact is they never did go—they hung right straight on all the time. We closed that month and started in the next on the basis of charging for all work. The basis of the charge was mainly for the labour, charged at 30 cents an hour, and all waste materials. We did not charge for anything that would be incorporated into our own property.

At that time, I think, we were running about 350 lights, and when at the end of the month we charged that up and it amounted to over \$800. We tried to collect it, but I presume we did not collect more than \$200 out of the \$800. People demurred and would not pay it. But it brought the thing to an understanding. Now, no work is done after the first installation unless it is to be paid for by our customer, and we get an order from our customers in which they order the work to be done and to charge it to their account. That brought the next month's charges down, and all we had occasion to charge them was something less than \$200. There could be no better proof in the world than that very fact that, as long as people did not have to pay for a thing, they were very free to indulge their fancies.

Another point: We send a man out to do a job and he comes in and charges three, four, five, six, or ten hours' time. The man for whom that work is done cannot account for more than an hour or two. Then comes your discussion on the payment of that account, and it is as a great trouble. We know nothing; we charge a man's time from the time he leave the station till the time he gets back and reports to us, and whether he has put in that amount of time, less the

\* Delivered before the N. E. L. A., Cape May, August 20th, 1890.

time of coming and going, of course we have no means of knowing; at least, we did not, but we get nearer to it now. That is one of the things that takes a great deal of time, and I have noticed that our charges for that sort of work are very much more equitable, according to the judgment of our customers, than they have been heretofore; and, moreover, we find that the men do a great deal more work.

Another question which I think can be very profitably discussed is that which relates to small matters of income on your revenue account. The electric lighting business is not in such condition that you can take the ordinary stand and say to the public, "You will take just what we can give you, and just as we want to give it to you, or get nothing." We make our contracts as specific as we can; but we have not got a contract under which we have not given more service than we agreed to give in that contract. The service rendered is never below the standard. We have lights running on the 12 o'clock service plan; and our contracts for that service cover seven hours of maximum burning. That would mean strictly that at no time was the service rendered by those lights to exceed seven hours, which, in the winter months, is from five to 12. But that does not do, because five o'clock is not early enough in three or four months of the year, when the lamps are sometimes lighted as early as three o'clock. It means rather an average of seven hours than it does a maximum of seven hours. In any city where there is a restriction on the running of wires, it is necessary that you put half night lights on all night circuits, with the object and purpose of switching them off, individually perhaps at 12 o'clock. A customer can hardly be relied upon to do that, and the only safe way to do it is to have them switched off by your own *employés*. It is the same with all night lights, which might be run, and sometimes are run. Those conditions must be met. You must give the people what they want, or you will finally lose your business, and you will have to be getting new business all the time.

As long as I have been connected with this association, and as large an acquaintance as I have among electric light central station men, I never have found any one yet who seemed to have any appreciation or any interest in knowing just exactly what his product cost him on the same basis on which he sold it. To get at the cost of a light, or of any particular part of it, it is very generally figured up as a horse-power. But the point that I have always contended for is this. I rent a light for a given length of time, for a year, if you choose, which is the most favourable contact that I consider that we can make, because it gives us the longest service. In doing that you figure it on the basis to furnish light 312 nights per year, which you sell at so much per light. Now, you really want to know, not what the 312 lights cost you, and how much you get for them, and take the difference, and let that be profit or loss just as it happens to be, but you want to know just what each one of these lights cost you, and you want to know it as a whole; you do not want to know whether it takes one horse-power or two horse-power, or half a horse-power, as there are a great many other things besides horse-power that enter into this question.

Another thing that I find to be a very common practice is, to have a uniform price for a light of a certain character, whether the contract is for furnishing light for six months or for a year. The same rate for the longer and the shorter term is unjust to your long contract customers. It is a very easy thing to rent lights during six months of the year, commencing the first of September, October or November, and it is a very easy thing to keep such customers, because they want the lights most at that time. But in the summer time people discontinue the use along about the first of March, April, May or June, and so you have an idle lamp during the summer, in which you have your money invested. I contend that the user of that lamp has no right to expect to get that light at the same price per diem as the man who pays you for a service of 312 nights in the year. But that is almost universally done.

There is just as much reason for a graduated scale of prices based upon the amount of service you get from your customer as there is for fixing the price for a 10 o'clock circuit, a 12 o'clock circuit, or an all-night circuit.

When that first became apparent to me the first effort I made to equalise the prices on that basis showed me that there was really nothing to go upon excepting guess work. After the first year's experience I had the result of my own experience to go by, by means of which I could work it out in a little better shape. But I found myself doing an injustice to our customers when I thought that I was doing an injustice to myself. I found that I was charging more people too much on that basis and others too little. This puts the company in the position of making a uniform contract in which they can say to every customer, or to every person that comes into the office, that the company will duplicate for him any contract that it has on its books.

### INDIAN TELEGRAPHS.

THE following information respecting the telegraphs of British India is extracted from the "Moral and Material Progress and Condition of India." The length of telegraph line and cable in India is now 33,462 miles, of which 1,568 miles represent the extensions of 1888-89. The number of messages for that period were 2,978,888, an increase of 176,669 over the previous year. The increase of messages was wholly under the head of "private messages," there having been a considerable decrease in the number of State or public service messages. The receipts were Rx. 632,247, yielding a surplus of Rx. 198,024 on the revenue account, and equal to 4.45 as against 5.46 per cent. in the preceding year on the capital outlay. The decrease of receipts was due to the reduction in the number of State messages, especially in Burmah.

The additions to the capital expenditure during the year amounted to Rx. 174,362 or Rx. 60,593 less than the previous year. On the Indo-European Telegraph line *via* Teheran the nett revenue was £19,138, equal to 1 $\frac{3}{4}$  per cent. on the capital outlay of £1,124,126, but if the line be debited with the annuity of Rx. 18,827, payable to the shareholders of the late Red Sea Telegraph Company, the surplus of the year is reduced to Rx. 1,111.

### CORRESPONDENCE.

#### Electrical Heterodoxy.

Having read your article in last week's issue on "Electrical Heterodoxy," it recalled to memory a little piece of apparatus I devised some years ago, for the amusement and instruction of some juvenile friends. I think it gives experimental proof of your explanation of the test tube experiment.

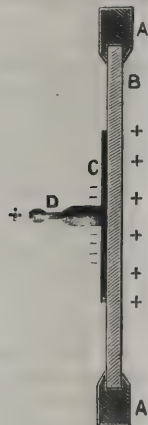
An ordinary school slate is taken, and the slate removed and a sheet of glass inserted in the frame. In the centre of one side of this glass is attached a sheet of tinfoil, and to centre of foil is attached a smooth, round-ended cork neatly covered with tinfoil; from end of cork projected a small metal ball. The sketch represents a section.

On warming the apparatus and rubbing the plain surface of glass with a piece of silk for a short time, a spark may be drawn from the projecting ball on opposite side of glass.

Must I conclude the electricity passed from the rubbed side and through the system and out by the ball? Without going into the controversy of whether electricity is generated or separated, the explanation the juveniles received was, that, by the expenditure of an amount of muscular energy, the plain surface is positively electrified, which induces a negative char e

on the other surface, thus disturbing the electric equilibrium of the whole system with the result of the exhibition of positive electrification on the ball.

The fact that electricity did not pass through the glass was shown in a very simple way, holding the slate horizontally, cork down, and placing a sheet of foil on the glass, then connecting it with the ball by means of a discharger, when a second spark occurs, and the equilibrium is restored.



A, A, Slate frame; B, Sheet of glass; C, Tinfoil; D, Cork and projecting ball;  
+ —, Shows condition of electrification, though — sign should be between foil and glass.

Now, I think, this exactly shows what occurs in the test tube experiment, the inner surface of which is represented by the uncoated surface of the glass. To my mind, this test tube experiment of the apparent passage of a spark through the glass, rather points to the probability that conduction is an effect of polarisation.

Assuming the spark an evidence of conduction, and its passage an evidence of current, then if the conduction is absolute, the glass should be perforated; but, no, there is a break of continuity, and this assumed current takes another quality, and one that we can grasp, it apparently gets through that glass; but how, and does it get through? No, it takes up the quality assigned to induction, the dielectric glass is polarised, we know the inner and outer surface of the end of that test tube must be under a state of polarisation, one surface being positively electrified and the other negatively; this is a fact, because we know the effect produced by a charge in this way.

Are we driven to the conclusion that that which we call current has passed by conduction through the glass by the agency of polarisation or induction; if this be so, then what is the difference between conduction and induction, and are they not *both* explainable by polarisation? The glass end of the test tube is equally a portion of the path; then why should we conclude the energy passed through the air space by conduction and through the glass by induction; rather should we say the whole passage is completed from atom to atom through the agency of polarisation, and therefore induction, or equally conduction; but why this clashing of words, why not say at once, polarisation?

I do not see that the insulated gas flame experiment proves more than that the flame is electrified in sign similar to that from which it is deflected. I have not seen the original description of the experiment, but base my conclusion on the description in your issue of last week. It does not follow that because we speak of + and — electrification and polarisation that we believe, or even assume, there are two forces.

There is such a thing as stress and strain, and I, for one, can see no reason why we should consider electric stress and polarisation as distinct. I am firmly of belief the generation of current by the passage of a conductor across a magnetic field is one of strain, and bearing in mind that if a bar of copper be suspended in a magnetic field, it will, diamagnetically, set in a definite direction. What occurs if that bar is urged through the field in a *definite position*? Must there not

be a strain on the particles of that bar, and will they not turn toward the position in which the bar would set if free, and return from that position as the bar passes out of the field, do not the atoms, molecules, or particles of that bar oscillate, turn or rotate?

What do we find when the bar is in closed circuit and approaches and enters the field, and as the atoms, molecules, or particles are strained, a current of electric energy is urged in one direction, and as the bar passes out of the field and the atoms, molecules, or particles swing back, a current of electric energy is urged in opposite direction? Shall we not call this straining or swinging back dynamic or oscillating polarisation, and polarisation in which set occurs, static polarisation? Having got thus far, is it possible that Faraday, Tyndall, and others, in their brilliant diamagnetic experiments, omitted to test whether an electrostatic effect is produced by resisting the diamagnetic movement through fixing, say, the bar of copper, and thus allow the atoms, molecules, or particles to assume a polarised set?

It would be an instructive discovery to find by diamagnetic experiment that the set polarisation means static electrification, and the oscillating polarisation dynamic electricity. There is room for thought and experiment in this direction.

Henry Sutton.

September 13th, 1890.

#### French v. English Steel.

Kindly insert the enclosed letter in your valuable REVIEW, and oblige, yours respectfully,

J. A. Parkes.

September 19th, 1890.

"19th Sept., 1890.

"W. H. Preece, Esq., F.R.S.

"Sir,—I have been much interested by reading in the ELECTRICAL REVIEW the report of your paper on the quality of magnetic steel, and much pleased to observe that the sample magnets made by Mr. Marchal are superior to the others. The cause of my satisfaction is that the steel used in making these samples was furnished by me to Mr. Marchal. I have supplied him for some years past, and the magnets which procured him the only award given specially for magnets in the Paris Universal Exhibition of last year were also made of MM. Levick, McGillivray & Co.'s steel sold by my intermediary to Mr. Marchal.

"Your conclusion, therefore, that French steel is better than English needs modifying. Nevertheless, I shall not envy the reputation of French steel, if the French Government and public companies continue to purchase of me as heretofore.

"I hold myself at your service to furnish any further information that can be of use to you in pursuing your interesting and practically useful investigations.

"I am, Sir,

"Yours very respectfully,

"J. A. PARKES,

"Paris Agent of Levick, McGillivray & Co."

#### Prof. Elihu Thomson's Alternator.

The publication of an abstract of my specification describing an alternating dynamo of new design has elicited some correspondence in your paper, concerning which I think I may make a few statements.

The principle of utilising the changes of magnetic force without reversal in generating currents is certainly not new, as I designed machines working on this principle as far back as 1877–78.

The merit of the new machine is that it is a practicable machine to build and to operate, and at the same

time that its efficiency will undoubtedly be high, as the preliminary tests of a machine built to run 1,000 lights have shown that it can carry 1,500 lights quite efficiently. The indications go to show that machines can be made to have a commercial efficiency of 90 per cent. or over.

I am tempted to be somewhat amused at the criticisms made on the character of the Field as being inefficient, and I refer particularly to the statement of Pyke and Harris in their letter appearing in your issue of August 29th:—"Whereas, in Prof. Thomson's machine, it is apparent there is a considerable loss in the Field, more particularly the revolving part of the same." Now, it happens that the machine, as constructed, shows no evidence of any heating in the revolving portion as well as other portions; but, on the other hand, that this portion of the machine keeps delightfully cool, and that the heating is in the wire and only that due to whatever density of current may at any time be flowing.

Concerning the theory of the machine, it may not be out of place to give my views on the subject. I do not think that the stationary iron which supports what may be termed the armature bobbins, is entirely free from reversals of magnetism, but that under heavy loads there may be slight reversals occurring in certain portions of the iron, due to the flow of the armature currents themselves, and particularly those portions influenced by the armature wire which are not at the same time under the influence of the field poles. Whether the lines of magnetism are actually carried around with the revolving consequent poles or not is a question which it is difficult to answer, but the actions would be the same whether they are or not. If they are carried around by the consequent pole, the coils opposite them or the armature wire would be cut by concentrated bundles of lines issuing from the revolving consequent pole to the exterior iron, and if the lines do not rotate with the pole, then the armature wire would be cut by lines springing back from one division of the consequent pole to the next succeeding division as such pole revolves.

The details of the design will probably determine which of these actions will take place, and, in most cases, perhaps both the actions of bundles of lines carried forward, combined with the recession of lines backwards from one division of the revolving pole to the next succeeding, may really take place.

In the large machine which I have, the laminated iron carrying the armature coils or induced coils is divided into a number of sections or segments of a ring, and machines have also been built in which there is no iron projecting from the outer laminated portion towards the revolving pole. In this case, of course, the closure of the magnetic circuit is almost uniform throughout the revolution.

I had not intended to publish anything concerning this machine until the work of building and testing the machines of large size had been completed, but the extracts from my specification have led to sufficient discussion to warrant me in making the statements preceding.

Elihu Thomson.

Lynn, Mass., September 10th, 1890.

#### Re The Bath Installation.

In reply to Mr. Massingham's letter I wish to point out that my quarrel was on September 3rd. The alleged carelessness was based on an accident occurring at midnight, September 1st.

You will find on referring to my report of the breakdown of August 31st, dated September 1st (and which was written early in the morning, posted to catch an early mail, and which would be delivered at your office during the afternoon or evening), that I did not conceal the fact that I was working on the installation.

With the failure of August 31st, due to carelessness in the boiler-house, I, as engine-driver, had nothing to

do, and you will find the information I supplied you with to be correct, should you care to make further enquiries.

You are at liberty to publish all the above or any extract of it with my full name and address.

Charles Powell.

September 22nd, 1890.

#### Fire Office Rules.

As you have mentioned my name in connection with the recent correspondence in the *Times*, of which the leading article on Fire Risk Rules in your issue of the 20th inst. is the result, perhaps you will permit me to make a few further remarks on the subject.

There is unfortunately a tendency in certain quarters to make light of the difficulties incidental to electric light wiring, and an idea that no great experience is required to enable anyone acquainted with the ordinary principles of electrical science to draw up trustworthy rules.

Contractors and others who have experienced the unforeseen, perplexing, and vexatious failures of insulation that from time to time occur even with the best of work and material, will agree that this is not the case at all, and that the practical difficulties are in some cases much greater than many apprehend.

As I have already stated in the *Times*, it is much to be desired that, if an electrical committee be appointed by the Institution of Electrical Engineers, or any one else, to confer with the insurance companies and draw up new rules, care shall be taken to arrange that the majority of those forming such a committee be men having a real practical experience of the subject from the contractors and supply companies points of view, and not mere secondhand information or theoretical knowledge, however eminent.

That a word of warning is required as to this, is evident from a glance at the names of those who composed the committee that drew up the existing Institution Fire Rules. The list comprises men of the highest distinction and standing in the electrical world; men whose services to science it would be impossible to overestimate; but among the whole 22 names, of which seven are those of professors, there are not above half-a-dozen who can possibly have had any practical experience of electrical wiring—at all events, as commercially carried out.

Prof. S. P. Thompson has recently designated the Institution Rules as "a dead letter," and as "invertebrate." On the contrary, they are in many respects an admirable set of regulations, but it is idle to deny that they are capable of considerable improvement, and that a committee having a larger admixture of the practically experienced element could now frame a set very superior in many particulars.

The electrical industry will, I am confident, agree as to this:—If any one set of rules is to be universally and exclusively adopted, let us have these rules as perfect and as definite as practical experience can make them. Let these rules clearly state what is and what is not admissible, and distinctly differentiate between those regulations that are obligatory and those that are merely recommended. Let us have a thoroughly competent committee to draw the rules up, and let this committee be a standing one, so that the rules may be revised from time to time as the progress of electrical science and the accumulation of experience renders this necessary.

By whom, whether the Institution of Electrical Engineers or the Electrical Trades Section of the London Chamber of Commerce, such a committee, is appointed, is of secondary importance, provided the insurance companies are satisfied and due weight and authority be assured. The real question of moment is the constitution of the committee itself and the practical competence of those who serve on it.

A. A. Campbell Swinton.

September 22nd, 1890.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. XXVII.

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## "A REVOLUTION IN THE COPPER MANUFACTURING INDUSTRY."

A WELL-KNOWN promoter was once asked how it was that the public so readily subscribed to unsound schemes, formed upon lines that had been exposed years before, and he replied, "My dear sir! There's a fresh crop of fools born every day." If this dictum be true, it is possible that Elmore's Austro-Hungarian Patent Copper-Depositing Company may be subscribed four times over, as, according to the prospectus, has been the usual fate of other members of the family.

This company is formed for the purpose of acquiring the Elmore patents for the empire of Austria-Hungary at a price of £50,000 in cash, £50,000 in shares, and the premium on the shares now offered. 75,000 shares are now offered. The premium is 10s. per share, so that the possible purchase price is £137,500. And what does the company obtain in exchange for one hundred and thirty-seven thousand five hundred pounds? Two patents, of many figures, relating to the discovery made by Messrs. Elmore for manufacturing copper articles direct from rough copper bars.

Our readers are by this time familiar with the material of which a copper-depositing prospectus is made. The new applicant for public approbation has the usual Elmore features. There is a description of the process, a reference to reports on the process, a summary of the advantages of the process, and a so-called estimate of profits. There is also a paragraph headed, "Character of Investments." We have our own opinion of the character of the investment, which does not accord with the view of the prospectus; but there is one statement in this paragraph which we think should be further enquired into. It says the investment is offered in a company formed to work an invention *producing, at a cost hitherto unknown*, articles admittedly of unprecedented quality, and in large demand. The phrase which we have italicised is, of course, intended to mean that the

articles are produced at a less cost than has been known before by any other process; but, unless we are much mistaken, it may be applied to the process the patents for which it is proposed to sell. If we had doubts on this point, they would be set at rest by the rapid multiplication of Elmore Companies.

We see it reiterated in their prospectuses that the Elmore process is believed to be the most important metallurgical discovery of recent years, and that it will take the same leading position in the copper industry that Bessemer's did in iron and steel. It is not stated who formed this opinion or who subscribes to it as an article of faith, but the mere statement is of value, for it gives an opportunity of recording that Bessemer has received a million in royalties. We need not trouble to make a comparison between the two processes or the methods of their development. We do not see any comparison in their respective values. It took Bessemer some years, and there was a good deal of solid work done, before he got his million. Hardly any time has elapsed since Elmore took out his patent, and no commercial work at all has been done, yet the Elmore people must have absorbed a good many hundreds of thousands of pounds already, and the Timbuctoo Company is not out yet. We wish Sir Henry Bessemer's name were invoked for a better purpose, and placed in better company.

We have to consider what the Elmore process is, and on what grounds a company is asked to pay £137,500 for the Austro-Hungarian rights. The electro-deposition of copper is an old and well-known process. It is alleged that for commercial purposes there is not sufficient tenacity in the deposited coating, and that some mechanical assistance is required to obtain the necessary result. We do not know exactly how much Mr. Elmore claims to have discovered, or how much he claims to have invented, but speaking broadly we believe that the application of the burnisher constitutes his sole claim. Quite suffi-

cient to entitle him to credit as a discoverer if the application enables some useful purpose to be served which could not have been served before, and quite sufficient to entitle him to reward as an inventor if the invention is novel and the patent for it can be sustained. But we are without any information of a practical character that the invention is a useful one. Moreover, as the "Transactions of British Naval Architects," for 1889 show, there is something to be actually said in opposition to electrically deposited tubes. Mr. Clark (an exhibitor at Glasgow Exhibition) said:—"We have made tubes experimentally in the same way (electro-deposited), but they have not proved either so good or so cheap as tubes made by the system now in use, although the copper gives a remarkably close grain fracture, and is excessively tough. At the same time the point which I particularly draw your attention to is this, that at the temperature of  $390^{\circ}$ , which I understand is the working pressure of these main steam pipes, the electro-deposited copper gives no better result; in fact, a shade worse result than seamless-drawn copper . . . . Moreover, as the diminution in strength between the normal temperature and  $390^{\circ}$  in the case of the electro-deposited copper is so very great, it would seem logically to follow that if you got anything higher than  $390^{\circ}$  it would decrease in the same ratio, and would thus become much worse than a seamless solid-drawn copper pipe, &c.," and to conclude—"I may say in conclusion that we have given considerable attention and time to this question of making tubes by electro-deposition, but have come to the conclusion that it is not so satisfactory a method as that of making them by the seamless drawn process." Mr. W. Parker also reports:—"The tenacity of the electro-deposited copper was, in its cold state,  $24\frac{3}{4}$  tons per square inch, the solid drawn had a tenacity of 20 tons, and the plate copper a tenacity of about 14 tons. When subjected to high temperatures these high tenacities vanish very quickly. At a temperature of  $390^{\circ}$  F., equal to the pressure of steam at a pressure of 200 lbs. per square inch, the electro-deposited falls to 15.3, or a loss of 61 per cent.; the solid-drawn to 14, or 30 per cent.; and the plate to  $10\frac{1}{2}$ , or 25 per cent."

Mr. Stepney Rawson has informed a shareholders' meeting that some incredulous copper worker (name not stated) was astounded at the result attained. Directors have made more or less vague statements of the progress of the work and its wonderful value, and the great misfortune of the breakdown of an engine, but the commodity is hardly yet on the market. The value of the process commercially is an unknown quantity. Yet companies are brought out in a prodigal manner, and money squandered for rights of one sort and another in more prodigal fashion. If the engine had not broken down the manufacturing might have been in full swing, the cost of the process known, and estimates dispensed with. We hope the makers will receive adequate reward for the breakdown in event of its proving advantageous to the parties interested in the promotion of these further companies.

It is useless to attempt to disguise the fact that

Elmore's process has, up to the present, been simply a promoters' puppet. Parallels are to be found, and the eventual outcome may consequently be anticipated with certainty. The original Brush Company will be in the recollection of our readers. What became of its numerous offspring? They were simply acquired by and re-amalgamated with the parent company at a very considerable direct loss to investors and indirect loss to the electrical profession. Water-Gas is a later example. Perhaps there is a greater similarity to the famous Date Coffee Company in the Elmore system of issues. The Date Coffee Company made a great deal of a contract entered into with Messrs. Mac Something to take their output for a certain period. It was worthless. We notice a similar arrangement, only less definite, on the part of the Elmore Wire Company to dispose of their output for 1891. We wonder what the output of 1891 will amount to, or whether it is certain there will be any output at all?

Vagueness and uncertainty, with a good deal of unhealthy high-falutin, has been the characteristic of the Elmore information up to now. We turn in vain to the prospectus of the Austro-Hungarian Company for anything different. In the first paragraph the process is described as "extremely valuable." This is about the only definite statement the directors permit themselves to make on their own authority. The principle of devolution of responsibility is ably carried out in the remainder of the prospectus.

It is surprising that any set of business men should permit their names to stand at the head of a prospectus with such a paragraph as that headed, "Estimated Profits." In the English company's prospectus it was estimated that under certain most disadvantageous circumstances the profits would amount to over £100,000 a year. The directors of the English Wire Company were confident that another £100,000 a year would fall to that company's lot. That makes £200,000 a year altogether for England. The population of Great Britain is 35,000,000, of Austria-Hungary 40,000,000. "The directors do not give a formal estimate lest it may be thought exaggerated," but the little sum which they practically ask the investor to work out for himself is:—as 35 is to 40 so is £200,000 to the Austro-Hungarian Company's income. We do not remember to have seen any instance in which one worthless estimate has been so shamelessly built up on another equally worthless, and a conclusion suggested by so absurd a comparison. China has a population of 370,000,000. Investors should wait till the China Company comes out. They can see for themselves how much better their prospects will be.

Considerable prominence is, of course, given to the market value of other Elmore shares. The Foreign and Colonial Company is at a premium. There is no reminder that it might well be accounted for on the strength of the purchase price of the precious rights now parted with. The public should clearly understand that the price of Elmore shares is simply a measure of the reliance of the holders on the crop of latter-day fools, being sufficiently large to absorb more sub-companies.

There is little else in the prospectus beyond such useless announcements as that the Managing Director and Mr. Stepney Rawson are now taking a trip in Austria (doubtless at the company's expense) engaged in the selection of a site for the company's works, and that the arrangements generally have been carried through by Woodhouse and Rawson United, Limited, who floated the French Company, and whose valuable co-operation is secured in the organisation of this company. We have tried to discover what this ambiguous statement means, but without success. We fail to see why an investor should be grateful to Woodhouse and Rawson, United, for making arrangements whereby he should join in paying away £137,500, mostly in gold, and expend some more gold in the working of a process which may or may not deposit some coppers in his pocket in return. Nor do we see how their continued co-operation is to be made so valuable—to the investor.

We have before expressed our wish for something in the way of definite information on the Elmore process. We have also commented on some of Woodhouse and Rawson United company promotions. We regret that we are now compelled to repeat our warnings and to again draw attention to the disadvantage which the electrical profession incurs by such proceedings. We must perforce assume that Messrs. Woodhouse and Rawson United and the directors of the Elmore Company are persuaded (or persuade themselves) that the invention is valuable and the process economically workable, but it is not easy to characterise in safe language the conduct of those who continue to foist upon a public necessarily ignorant of its technical value a series of companies for the development of an unproved industry. The game, as we have already remarked, has been played before, and doubtless will be played again when another crop of fools shall have become ripe for it; but at least we hope the electrical industry will not be the foundation upon which such a terrace of unhealthy tenements will be built.

It is too late to stop the transfer of cash from the pockets of the public to those of the promoters. That has already been done to a large extent, and the present company, of course, like all its predecessors, closes its subscription lists before the publication of the technical journals. But there is one direction in which good money may be prevented being thrown after bad, and we earnestly press it upon the consideration of Elmore shareholders. It is a distressing incident in this process of company manufacture that sites have to be selected (and paid for), factories built, and machinery purchased, staff engaged, and wages paid.

We cannot too often reiterate that there is no proof of the commercial value of the process. If there were such proof, it is extremely unlikely that there is work enough for a tube factory and a wire factory in England, and factories elsewhere in every country in the world. We will confine ourselves to saying that the possible waste of money in this direction is a sad feature of the business, and we strongly commend the Austro-Hungarian shareholders to see to it that Lieut.-General Fraser and Mr. Stepney Rawson's selection of a site be

not confirmed, and that not one penny be devoted to the building of a factory until incontestable proof is forthcoming not merely that the process is practicable, but that Austria-Hungary offers a field of sufficient extent to justify manufacture on the spot, and further, to satisfy themselves that Austro-Hungarian Patent Laws, and Austro-Hungarian commerce give them a reasonable probability of fixity of tenure for any business they may start. The purchase money of the patents is a known sum. Let the waste stop there.

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A RECENT issue of the *Wissens*  
The pathological effects  
of the Electric Light. *Wochenschrift* contains a short paper  
by a German medical authority upon

the pathological effects of the electric light. The glare of the electric light exercises a deleterious effect upon the eyesight of people who are exposed for too long a time to its action, and this effect is proportional to the power of the lamp. It might be thought that the injurious effects of the electric light upon the eyes are due to the fact that this light contains a preponderance of chemical rays, violet and ultra-violet, but this is not the case, for the eyes are not similarly affected by illuminations of that character. According to the writer, the "tired" sensation in the optic nerve and the local inflammation which accompanies it, are both due to the fact that the luminous waves proceeding from a powerful electric lamp are of very great intensity. The general symptoms induced in the eyes of people who have been exposed to the glare of unprotected lamps for too long a time are:—(1) Transient irritability of the retina; (2) local inflammation; (3) tears and "flashing" of light before the eye; (4) incipient paralysis of the eye. Usually, people experience sensations which are analogous to those which are felt when particles of foreign matter are present beneath the eye-lid. In order to prevent the sight being permanently injured, it is necessary to adopt hygienic shades, though these do not act thoroughly in reducing the intensity of the luminous waves. Rest must be sought, and the pain relieved by the application of cold water compresses. When the pain is almost unbearable—a calamity frequently suffered by those who have been exposed for many hours per day and for some time to the glare of powerful lamps—a medical man may relieve it by the injection of cocaine and atropine. The French call this peculiar malady *coups de soleil electriques*.

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A TELEGRAM from Florence says:—  
The Florence Electric  
Tramcar Accident. "When the Electric Railway Company

tried to recommence the running of cars after the recent fatal accidents an angry mob rained stones on the vehicles and threatened to kill the conductors. Such is the state of public feeling just now that it is thought the whole scheme will have to be abandoned. The guard who caused the first accident by, in a moment of tipsy recklessness, turning the brake the wrong way, is reported to be dying in prison." We trust that the excited state of the populace will soon give way to calmer reasoning, and that no such misfortune to the prospects of electric traction as that which now seems probable will result. Still, such fearful disasters as this, combined with the frequent fatalities from electric lighting circuits, will be made

the most of by those interested in opposition schemes. and the industry has already quite enough to contend against.

Killed by Electricity.

THE *Daily Graphic*, of Friday last, contained a notice of a fatal accident to a lineman in Omaha, who was instantly killed whilst engaged in cutting a wire. A Reuter's telegram on Saturday also announced two more deaths at Winchenden, Mass., the preceding day, through an electric wire (*sic*) coming into contact with an incandescent circuit. We suppose a high tension circuit crossed the other. At the present rate of fatalities it seems likely that this year will be a record in the States.

The Vaughan-Sherrin Battery.

ON the 28th May, 1884, Mr. Probert, the well-known Postal Telegraph expert, read a paper before the Society of Arts, on primary batteries. He stated that to liberate a horse-power hour of energy, a quantity of zinc must be oxidised equal to 2.022 lbs. divided by the electromotive force of the galvanic couple in use. As this is theoretically the minimum consumption, we do not usually expect to find a battery in practice giving results somewhat better than is actually possible, and yet this is what Prof. Silvanus Thompson practically shows to have been obtained in his tests of the Vaughan-Sherrin primary cell. It is possible that his voltage readings were not quite accurate, and that the weight of zinc consumed was understated; nevertheless, we are face to face with an impossibility; and this shows the uselessness of giving a report on the strength of the laboratory performance of one element. With eight or ten cells a small error of observation would have made but little practical difference; with one, a trifling mistake proves fatal, for 2.022 divided by 1.99 gives one lb. and one quarter of an ounce as the theoretical demand, instead of one lb. and a fortieth of an ounce which the Professor claims to have actually obtained in his laboratory. Even if the newer determination of 1.995 mentioned in Kempe's "Electrical Engineer's Pocket-book," and credited, we believe, to Sir William Thomson, is taken, the actual consumption is still less than the theoretical. It is hardly worth while to follow these tests any further, but we would like to ask Dr. Thompson on what he bases his estimate of 9d. to 10d. per Board of Trade unit as the net cost of electrical energy drawn from this battery? Mr. Probert showed very conclusively that to produce 12.5 horse-power hours in the most economical manner necessitated for materials alone, an expenditure of 8s. 3d., or deducting 1s. 2½d. for sulphuric acid, which apparently is not used in the Vaughan-Sherrin element (unless as part of the depolariser), say 7s. Now this means theoretically 6½d. per horse-power hour, or 9d. per Board of Trade unit. How, then, can Prof. Thompson's estimate of *net* cost, which if it means anything is held to be clear of all deductions, be reconciled with these figures? There might be one explanation and that is, that the depolariser costs little or nothing; but this cannot be so, or how account for the high E.M.F.? The Professor's opinion upon the motor seems based upon somewhat antiquated notions. We know of half H.P. motors of 70 per cent. efficiency, containing not more than 60 lbs. of dead weight per brake horse-power developed, so we fail to see anything special in the motor under consideration. The

tests credited to Mr. H. R. Kempe in his official capacity as a technical officer of the Postal Telegraphs are delightfully vague and apparently made to order. It will be noticed that the E.M.F. of the battery is not given, although we have reason to believe that it differs very considerably from Prof. Thompson's; the results, however, show that local action was not altogether a negligible quantity. Mr. Kempe's ideas of launch gearing and boats generally seem hazy. Surely he must be aware that the motor shaft should be coupled direct to the propeller, thus eliminating all gearing, and that every conceivable shape of craft is available, and has been tried by other electric launch builders. Why does Mr. Kempe consider that this battery is well adapted to motive-power purposes? Until we see the figures obtained in actual practice, say on a good spin with a bath chair or tricycle, we can only consider such data as that upon which we have commented as purely speculative and hypothetical. There is, however, a probability that these batteries may supplant the hired man for driving bath chairs, and if this turns out to be the case, there will be considerable demand for them at seaside resorts, judging from the number of interesting invalids always seen at these places. But whether an invalid could manipulate the apparatus unaided is quite another thing.

Candle Power.

AS is well known, the accurate measurement of the candle-power of a source of illumination is by no means an easy matter; but this is hardly an excuse for the continual exaggeration with which we meet with reference to the power of arc and incandescent lamps. Even the fact that the latter, when turned out fresh from the manufacturers hands have their full nominal candle-power, is misleading, as deterioration commences almost from the moment the lamps are run, and in a very short time, a building, which is stated to be lighted with so many lamps of a certain candle-power, can only justifiably be said to have that illumination at the outset. Allowing for breakages, &c., and the consequent eventual miscellaneous assortment of lamps of various ages which are grouped in a building, it is hardly an exaggeration we think to say that the actual is at least 25 per cent. below the nominal illumination.

Gas and Electricity.

THE *Gas World* in drawing attention to the exaggeration of the light value of electric lamps, says:—"It may be urged that the electrician cannot prevent this change (alluding to the deterioration of incandescent lamps), and that he is not, therefore, responsible for any deficiency in the light. Would such an excuse be of any avail with a gas company? Could it plead that the coal purchased was not of the quality anticipated, or, that through some defect in the apparatus, the photometric value of the light had fallen below a given standard?" To this, we answer, certainly not at the present day, when the deficiency of light is known to be preventable; but in the early days of gas excuses of the kind would have been perfectly justifiable, and could certainly not have been "laughed out of court," as the *Gas World* says. When electric illumination has had the experience of years, and its defects are better understood, then excuses will no longer avail.

## TRAMWAYS.

THE Americans are proud, and justly so, of the great growth of electric tramways and railways in the United States, and they are apt to sneer at the tardy introduction of electric traction into this country. The causes of this state of affairs have been frequently explained. Generally speaking, tramway companies, like railway companies, will not adopt any new system of locomotion until it has been demonstrated to be practically reliable, and to be superior to the existing methods of traction by horses or locomotives, as the case may be. Moreover, they do not care to run the risk of converting their present horse cars, or locomotives, into electric cars at their own expense, but rather regard at a distance the development of electric traction by the traction companies themselves; and, finally, they do not seem inclined to favour electric traction. It would therefore appear that electric traction companies must continue to "demonstrate" until they have shown that their systems are cheaper than those existing, when the tramway companies will commence to seriously consider the advisability of a change.

In the meantime it may be interesting if we give details regarding the tramways of this country, and of their cost of working. The latest obtainable returns of the tramway companies are to be found in *Duncan's Tramway Manual* for 1890. At the year ended 30th June, 1889, the total capital expended on tramway construction amounted to £13,664,591, the mileage of lines open to traffic being 949, as compared with 904 in the corresponding period of the previous year. The number of horses employed was 27,060, as against 25,832; of engines 539, as compared with 514; of cars, 3,645, as against 3,501; of passengers carried, 477,596,268, as compared with 428,996,045. The working expenses increased by 6·6 per cent., and the net receipts by 14·9 per cent. The ordinary working expenses of the principal companies are shown in the following table. By ordinary working expenses are implied traffic expenses, stables, general, law, and rates, but no allowances are made for repairs and renewal of track, corporation rent, mortgages, interest, &c. :—

Name of company.	Mileage.	Ordinary working expenses per car mile.
Belfast ... ..	15½	6·87d.
Dublin United ...	32	7·49d.
Edinburgh ... ..	18½	10·82d.
Glasgow ... ..	30	9·52d.
Liverpool ... ..	61½	8·00d.
London ... ..	21½	7·40d.
London Street ...	13½	8·88d.
North Metropolitan	41	8·55d.
South London ...	13½	8·00d.

It will be evident from the table that the working expenses per car mile are higher than those admitted at the meeting of the Tramway Institute referred to some time ago, namely, 6½d.; but the latter figure probably does not include stable expenses, general, law, and rates.

It may be mentioned that the Blackpool electric tramway is worked with a capital of £20,025. The miles run during the last financial year were 94,000, and the dividend paid 7 per cent. The Bessbrook and Newry Tramway Company has a capital of £10,000, and the last dividend paid was 4 per cent. No particulars are obtainable of the other experimental lines worked by electricity.

**Tenders for Electric Lighting.**—Contractors for electric lighting, steam, gas engine and boiler power, also for all kinds of lighting other than electricity, are required. Particulars from the Secretary of the Glasgow East End Industrial Exhibition, Mr. J. R. Chalmers, 133, St. Vincent Street, Glasgow.

THE VAUGHAN-SHERRIN SYSTEM OF  
ELECTRIC TRACTION.

THE so-called *new* primary batteries are again being prominently brought before the public. A few weeks ago the Parisians professed to be greatly interested in the performances of an electric tricycle invented by M. Million and which was to revolutionise electric traction by means of the employment of a new primary battery. This invention an English electrical engineer, Mr. J. Vaughan-Sherrin, of Ramsgate, has endeavoured to excel. He has not taken advantage of the facilities afforded for attracting public attention by the Thames embankment or the West End streets, but has contented himself with demonstrations of his inventions in that picturesque quarter known as Eagle Wharf Road, N. At No. 48 in that street the Vaughan-Sherrin Electrical Engineering Company, Limited, has taken temporary offices, and there one of our friends wended his way last week to witness the demonstrations.

There are on view a Bath chair, a tricycle, a wherry and a launch propelled by electricity. The main features of the inventions are a new primary battery and a special form of motor, but it is not easy to find any novelty in the make of the battery, or anything special in the motor.

The primary battery is of the two fluid type with sheet zinc and carbon. In each cell are three fixed carbons and two replaceable zincs. Very light plates are used, and the particular construction adopted permits these to be placed very close together, so that the internal resistance is very small. The outer cells are of gutta-percha, and in them are embedded the porous cells which surround the zincs. The liquid used in the inner cells is water, whilst that placed in the outer cells is a depolarising liquid of *special composition*, capable, it is said, of being produced at a low cost.

The E.M.F. is nearly two volts. The motor is a two-pole Gramme machine having the field magnets made in such a manner that while maintaining great mechanical strength it admits of very perfect lamination of the iron. When properly set there is no sparking at the commutator. Prof. Silvanus P. Thompson has conducted a series of tests of the performance of the battery. He states that :—

"In one of my tests one of these cells gave out a current of 8·75 ampères (average) for five consecutive hours, with an electromotive force (average) of 1·88 volts, although the cell was only about half filled at starting. In another more complete test a cell gave a discharge lasting rather more than nine hours, of an average strength of 6·5 ampères, the average electromotive force over the whole period being 1·99 volts. The amount of zinc consumed was only 73·1 grammes, being at the rate of 1·24 grammes per ampère hour. This demonstrates that the quantity of zinc consumed per (gross) electrical horse-power hour will be almost exactly 1 lb. and one-fortieth of an ounce. In a third and more elaborate test one of these cells gave a current of the average strength of 7·85 ampères for 9¼ hours; the average electromotive force over the whole discharge being 1·74 volts, of which 1·308 volts was available at the terminal as the working number of volts; the total quantity of current discharged was therefore about 72·6 ampère hours. The total evolution of power was 126·17 watt hours (or about equal to ⅙ of 1 horse-power for one hour), of which about 31·26 watt hours were expended upon the internal resistance of the cell, and 94·81 watt hours (or about ⅙ of 1 horse-power for one hour) were available for useful purposes. Eight such cells would furnish to the circuit the equivalent of 1 horse-power for one hour; for example, they would furnish a power equal to the tenth part of 1 horse-power for 10 hours.

"The quantity of zinc consumed during the 9¼ hours discharge was about 90 grammes, or a little less than ⅙ of a pound; and the quantity of depolarising fluid was about half a pint. There is very little smell from

these cells, and that only at the latter end of the discharge; in the discharge which lasted  $9\frac{1}{4}$  hours there was no smell of any kind for the first six hours. The efficiency of these cells when working at a discharge of about 8 ampères is about 75 per cent. Taking this figure and assuming that the motor used with the cells was appropriately constructed and adjusted to run at an efficiency of 60 per cent., it is clear that the total consumption of zinc for an actual nett mechanical output of 1 horse-power would be about 2 lbs. 14 ozs. per hour. Each cell, when filled, weighs  $6\frac{1}{2}$  lbs., and yields 11 ampère hours per lb. of gross weight; or at the rate of  $38\frac{1}{2}$  lbs. gross weight per gross horse-power of electrical output. I know of no battery, primary or secondary, which for a given gross weight of cell will yield as great an output. The economy of zinc is remarkable, the consumption being close to the theoretical limit. I estimate the net cost of electric energy from such cells at 9d. to 10d. per Board of Trade unit.

"The motor tested first by me weighs 40 lbs., and it is intended for an output of from half to three-quarters of a horse-power when placed in a launch or on a tricycle. To give out its full power it should be supplied with current at a pressure of 55 volts, when it runs at a speed of from 1,500 to 2,000 revolutions per minute, according to circumstances. In my tests the motor was mounted upon a special testing stand, and supplied with current from a dynamo-electric machine. The current and potential were respectively measured by means of an ampère-meter and a voltmeter of the ordinary standard type, and the mechanical efficiency was measured by comparing the amount of electric power applied to a motor with the output of which it was capable, as measured by its actual power exerted upon a mechanical brake or dynamometer. This brake consisted of a grooved iron wheel (keyed to the shaft of the motor) at the periphery of which was applied a cord of graduated breadth attached to pans for holding weights; this form of dynamometer being that devised by Ayrton and Perry. The speed was measured by a counter. In three experiments made the same day, the following results were obtained:—

"(1) Current, 14.5 ampères; pressure of supply, 36 volts; speed, 1,252 revs. per minute; torque on brake, 10.306 pound feet; total electrical horse-power supply to motor, 0.699; mechanical horse-power executed by motor, 0.3907; efficiency, 55.86 per cent.

"(2) Current, 18 ampères; pressure of supply, 46.5 volts; speed, 1,380 revs. per minute; torque on brake, 14.139 pound feet; electrical horse-power supplied to motor, 1.122; mechanical horse-power executed by motor, 0.591; efficiency, 52.63."

The third test gave an efficiency of 46.35 per cent. On another day four other tests were made, when efficiencies of 56.2 per cent., 52.9, 53.2, and 65 per cent. were obtained. The professor also states:—

"Considering the size and weight of this motor, and comparing its efficiency with that of the best motors of equal weight or equal power in the market, I consider the performance of Mr. Sherrin's motor very satisfactory. For so small a motor the power is high, being at the rate of one horse-power for only 62 lbs. of dead weight. The electrically-propelled Bath chair is fitted with one of Mr. Sherrin's smaller motors, and is driven by the current derived from ten of his cells. In a short run which I took in it, on unfavourable roads and in muddy weather, it ran at about six miles per hour on the level, and ascended a gradient of about one in eight at the rate of about two miles per hour. It was perfectly easy to manage, and the batteries gave no trouble either from spilling or fuming. I consider the electric chair a thoroughly practical and successful vehicle. Of the electrical tricycle I have made no trial pending certain alterations now in progress in its structure."

Mr. H. R. Kempe, of the Electrician's Department, General Post Office, has also tested the battery. He finds that during a four hours' continuous run, an average current of 8.856 ampères was taken from the battery, and that the consumption of zinc was under

7 per cent. in excess of the theoretical amount. He also states:—

"The efficiency of the battery with the mean current of 8.856 ampères was 65 per cent. This value, which is rather less than that obtained by Professor Thompson, practically confirms the tests taken by that gentleman, as the current taken out was in excess of that which was drawn in the test made by him. Had the battery been run with a lower current, the efficiency must have been proportionately increased. The drop of electromotive force at the end of the four hours' run amounted to 10 per cent., which is small, considering the small size of the cells and the heavy current drawn out. There was an entire absence of visible local action during the run, and the fumes given out were exceedingly slight."

A third report on the Bath chair has been furnished by Mr. P. Jensen, M.I.M.E.

It is claimed that the tricycle will travel at eight miles an hour, and that the Bath chair will run six miles an hour, and will, when the cells are fully charged, run for nine hours. At the demonstration last week, however, the tricycle, with full current switched on, travelled at six miles on the level, the Bath chair at about four miles, and the wherry at six miles an hour on the adjoining canal.

The Vaughan-Sherrin Electrical Engineering Company, Limited, is being formed with a capital of £25,000 to acquire the whole of the patents.

## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—LEEDS, 1890.

### CONTRIBUTIONS TO THE MOLECULAR THEORY OF INDUCED MAGNETISM.

By J. A. EWING, F.R.S., Professor of Engineering in University College, Dundee.

(Read before Section A, September 5th, 1890.)

As the facts of induced magnetism become better known, increasing interest attaches to molecular theories and increasing difficulty attends the theories that are current. Weber's fundamental conception that the molecules of iron or nickel or cobalt are always magnets, and that the process of magnetising consists in turning them from many directions towards one direction, has been strongly confirmed by the now well-established fact that there is a true saturation value, a finite limit to the intensity of magnetism, which may be reached or very closely approached by using a strong magnetic force.\* Without going further back, to enquire (with Ampère) how the molecules come to be magnets, we may take this conception as the natural starting point of a theory. But when we go on to examine the conditions of constraint on the part of the rotatable molecules which have been suggested to make the theory square with what is known about permeability, about residual magnetism and other effects of magnetic hysteresis, about the effects of stress, of temperature, of mechanical vibration, and so forth, we find a mass of arbitrary assumptions which still leave the subject bristling with difficulties. Many of the phenomena suggest, for instance, the idea that there is a quasi-frictional resistance which opposes the turning of the molecular magnets; this notion lends itself well to account for the most obvious effects of magnetic hysteresis and the reduction of hysteresis by vibration. On the other hand, it conflicts with the fact that even the feeblest magnetic force induces some magnetism. My object in this paper is to refer to another (and not at all arbitrary) condition of constraint which not only suffices to explain all the phenomena of hysteresis without any notion of friction, but seems to have in it abundant capability to account for every complexity of magnetic quality.

In describing Weber's theory, Maxwell points out that, if each molecular magnet were perfectly free to turn, the slightest magnetic force would suffice to bring the molecules into complete parallelism, and thus to produce magnetic saturation. He continues:—"This, however, is not the case. The molecules do not turn with their axes parallel to the force, and this is either because each molecule is acted on by a force tending to preserve it in its original direction, or because an equivalent effect is produced by the mutual action of the entire system of molecules. Weber adopts the former of these suppositions as the simplest."<sup>†</sup>

\* Ewing and Low, *Phil. Trans.*, 1889, A, p. 221; see also H. E. J. G. du Bois, *Phil. Mag.*, April 1890.

† Maxwell, "Electricity and Magnetism," Vol. II., § 443.

Weber supposes a directing force to act in the original direction of the molecule's axis which continues to act as a restoring force in that direction after the molecule is disturbed. This assumed constraint is quite arbitrary; moreover, if it were the only constraint, there would be no residual magnetism when the deflecting force was withdrawn. Accordingly, Maxwell modifies Weber's theory by introducing the further assumption that when the angle of deflexion exceeds a certain limit the molecule begins to take permanent set. The development of this, however, does not agree well with the facts.

The alternative which is offered in the sentence I have quoted from Maxwell was not followed up by him, and seems to have been very generally overlooked, notwithstanding its obvious freedom from arbitrary assumption. Several writers, notably Wiedemann\* and Hughest, have recognised the inter-molecular magnetic forces by suggesting that the molecules, when unacted on by any magnetising force from outside, may form closed rings or chains, "so as to satisfy their mutual attraction by the shortest path."† But Wiedemann expressly postulates a frictional resistance to rotation, which will prevent this arrangement from being more than approximately attained, and which may be more or less overcome by vibration.§

I lately commented on the fact that soft iron and other magnetic metals (notably nickel under particular conditions of strain<sup>1</sup>) show a remarkably close approach to instability at certain stages in the magnetising or demagnetising process.<sup>2</sup> When the magnetic force reaches a particular value, the rate of change of magnetism with respect to change of force may become enormous. Referring to this in a paper which has just been published,<sup>3</sup> Mr. A. E. Kennelly has reverted to the idea of chains of magnetic molecules held together by the inter-molecular magnetic forces, and contends that when such a chain is ruptured by applying a sufficiently strong external magnetic force it will fall to pieces throughout, and the molecular magnets which compose the chain will take their alignment suddenly. He accordingly sketches what he calls a "chain-theory" of magnetisation and an adaptation of the theory of Hughes, in which, however, he postulates an elastic resistance to the rotation of the molecules in addition to the constraint afforded by their mutual magnetic forces. Mr. Kennelly's remarks are highly interesting and suggestive; but I do not think (for reasons which will appear immediately) that the notion of closed magnetic chains can be maintained as a general account of the molecular structure of unmagnetised iron.

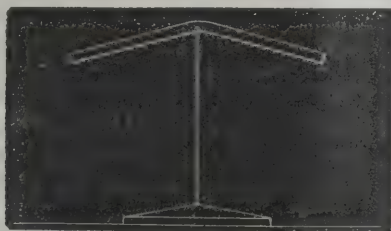
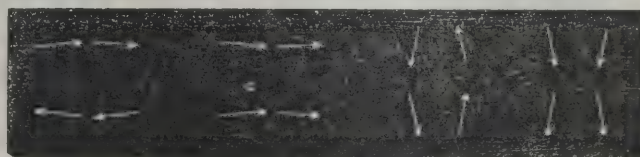


FIG. 1.

§ I have experimented on the subject by making a model molecular structure consisting of a large number of short steel bar-magnets, strongly magnetised, each pivoted like a compass-needle upon a sharp vertical centre and balanced to swing horizontally. We cannot readily imitate in a model the two degrees of rotational freedom possessed by the axes of actual molecular magnets, but a group of magnets swinging in one plane gives a sufficiently good general idea of the nature of the equilibrium which is brought about by inter-molecular forces, and the manner in which that equilibrium is disturbed when an external force is applied. The model is very easily made. Each magnet is a piece of steel wire about one-tenth of an inch in diameter and 2 inches long (fig. 1), bent in the middle to bring the centre of gravity below the point of support. The hole, or rather recess, for the pivot is made by a centre punch: the pivot itself is a sewing-needle fixed upright in a small base-plate which is punched out of a sheet of lead. The bars swing with but little friction, and their pole strength is sufficient to make the mutual forces quite mask the earth's directive force when they are set moderately near one another. The group is arranged on a board on which lines are drawn to facilitate regularity in grouping when that is wanted, and the board slips into a large frame or open-sided flat box wound round the top, bottom, and two sides, with a coil through which an adjustable current may be passed to expose the group to a nearly homogeneous external magnetic force. The coil is wound in a single very open layer, through which a sufficiently good view of the group inside

is obtained.\* A liquid rheostat with a sliding terminal is used to secure continuity in varying the magnetic force. It is scarcely necessary to add that the magnetic force which is applied to the group is too weak to have any material effect on the magnetism of individual bars. It alters their alignment only, just as a magnetic force alters the alignment of Weber's molecular magnets.

When a number of these magnets are grouped either in a regular pattern or at random, and are left after disturbance to come to rest free from external magnetic force, they of course assume a form which has no resultant magnetic moment, provided the number be sufficiently great; but it is apparent that they do not arrange themselves in closed chains. Any such configuration would in general be unstable. Many stable configurations admit of being formed, and if the magnets are again disturbed and left to settle, the chances are much against any one configuration immediately repeating itself. One general characteristic of these configurations is that they contain *lines* consisting of two, three, or more magnets, each member of a line being strongly controlled by its next neighbours in that line, but little influenced by neighbours which lie off the line on either side. Thus, if there are two magnets simply, they form (as might be anticipated) a highly stable pair, thus:—



if the inequality in distance be not too great. All these configurations are stable, and the condition of least energy, while making the first of them the most probable, does not prevent the occasional formation of the others. In a long line, the same condition leads in general to this formation:—



but it is by no means uncommon to find a line broken into two or more sections, thus :—



Seven magnets grouped so that the centres of six form a regular hexagon, with one in the middle, have a great variety of possible stable configurations, of which these are examples :—

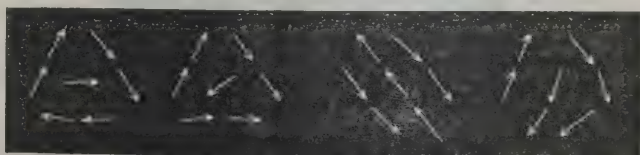


FIG. 2.

Experimental study of the forms which may be assumed by groups, and of the vibrations which may be transmitted through groups, is interesting, but to pursue it would be beside my present purpose. In all cases, the configuration assumed by a group is such that there is stability for small displacements, but different positions of the group may be stable in different degrees, and if members of the group be turned through a sufficiently great angle, they become unstable, and fall into a new position of stability, bringing about a partial reconstruction of the lines that characterise the group. Special interest attaches to square patterns, from the fact that iron and nickel (probably cobalt also) crystallise in the cubic system. In a square pattern of many members, we find, in general, lines running parallel with all sides of the square when the group settles without directive force after a disturbance.

Let the group, or collection of groups, be subjected to an external magnetic force,  $H$ , gradually increasing from zero. The first effect is to produce a *stable* deflexion of all members except those

\* Wiedemann, *Galvanismus*, second edition, Vol. II. (1), p. 373.

† Hughes, "Roy. Soc. Proc.," May 10th, 1883.

‡ Hughes, *loc. cit.*

§ Wiedemann, "Phil. Mag.," July 1886, p. 52; *Elektricität*, vol. iii., §§ 784-785.

|| See a paper by H. Nagaoka, "Journal of the Science College of the University of Tokio," vol. ii. 1888, p. 304.

¶ "Journal of the Institution of Electrical Engineers," No. 84 (1890, pp. 38-40.

\*\* *The Electrician*, June 7th and 13th, 1890.

which lie exactly along or opposite to the direction of  $\mathfrak{H}$ . This results in giving a small resultant moment to the group (assuming that there was none to begin with), which increases at a uniform or very nearly uniform rate as  $\mathfrak{H}$  increases. This corresponds to the first stage in the magnetisation of iron or other magnetic metal (a, fig. 3). The initial susceptibility is a small finite quantity, and it is sensibly uniform for very small values of  $\mathfrak{H}$ .

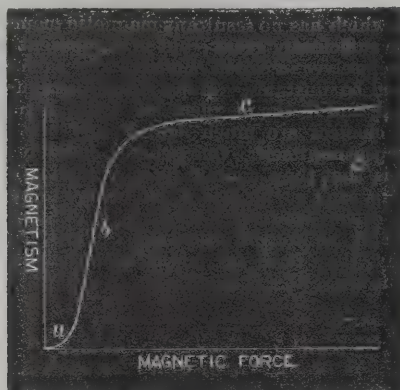


FIG. 3.

Suppose that, without going beyond this stage, we remove  $\mathfrak{H}$ ; the molecular magnets, not having been deflected beyond the limit of stability, simply return to their initial places, and there is no residual magnetism. This, again, agrees with the fact that no residual magnetism is produced by very feeble magnetising forces. Up to this point there has been no magnetic hysteresis. But let the value of  $\mathfrak{H}$  be increased until any part of the group becomes unstable, and hysteresis immediately comes into play. At the same time, there begins to be a marked augmentation of susceptibility—that is to say, a marked increase in the rate at which resultant moment is acquired. It is not difficult to arrange groups in which the state of instability is reached with one and the same value of  $\mathfrak{H}$  throughout the group. But, in general, we shall have different elementary magnets, or different lines of them, reaching instability with different values of  $\mathfrak{H}$ . The range of  $\mathfrak{H}$ , however, which suffices to bring about instability throughout the whole, or nearly the whole, of the members in most groups is not large; we, therefore, find in the action of the model a close analogy to the second stage (b, fig. 3) of the process of magnetisation, in which the magnetism rises more or less suddenly, as well as to the first stage (a).

During the second stage (b), the magnetic elements fall for the most part into lines which agree more or less exactly with the direction of  $\mathfrak{H}$ . If, at the end of this stage, we remove  $\mathfrak{H}$ , we find that a very large proportion of the moment which the group has acquired remains; in other words, there is a great deal of residual magnetism. To take an instance, suppose we have a group lying initially as in fig. 4, and apply a magnetic force,  $\mathfrak{H}$ , in the direction sketched, the first stage (a) deflects all the molecular magnets slightly, without making any of them become unstable; the second stage (b) brings the molecules into the general direction shown in fig. 5, or rather, that is the direction they assume when

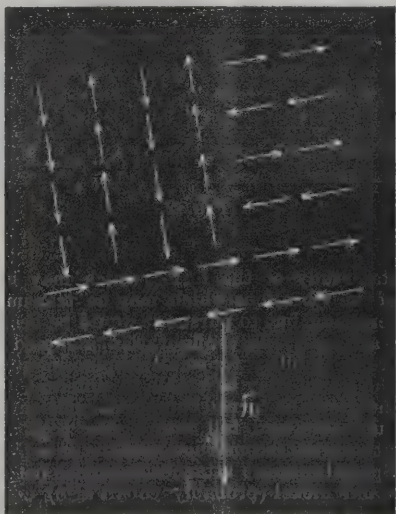


FIG. 4.

$\mathfrak{H}$  is removed, and the residual magnetism contributed by the group is then the sum of their moments resolved along  $\mathfrak{H}$ . When  $\mathfrak{H}$  is acting, the components along  $\mathfrak{H}$  are slightly greater, for the molecules are then (stably) deflected through a small angle towards the line of  $\mathfrak{H}$ .

Let  $\mathfrak{H}$  be further increased—we now have the third stage (c)

(fig. 3), which consists in the closer approach to saturation that is caused by the molecules being more nearly pulled into exact line with  $\mathfrak{H}$  (fig. 6). Whether there will be instability during the deflection of them from the lines of fig. 5 will depend on the closeness of the poles, and on the inclination of the lines of fig. 5 to the

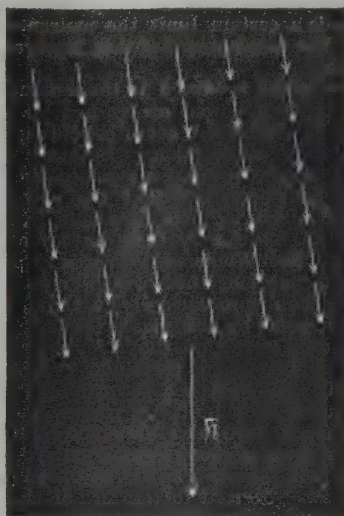


FIG. 5.

direction of  $\mathfrak{H}$  (see below). In some groups saturation will be complete with a finite value of  $\mathfrak{H}$ ; in others, it will only be closely approximated to. In magnetising any actual specimen of iron, we have, of course, to deal with a multitude of groups the lines to which lie at very various inclinations to  $\mathfrak{H}$ . If we remove the force  $\mathfrak{H}$  at a point in stage c, we find very little, if any, more residual magnetism than was found at the end of stage b. The ratio of residual to induced magnetism is a maximum about the end of stage b, and diminishes as stage c proceeds. This, again, agrees completely with the observed facts.

There is some hysteresis during the removal (whether complete or partial) and reapplication of magnetic force, because (provided we have enough groups to deal with) there will be some lines of elements which pass to and fro through a condition of instability during the removal and reapplication of the force. For certain inclinations of the line, the movements are not reversible.

Suppose, next, that having applied and removed a strong force,  $\mathfrak{H}$ , leaving strong residual polarity, we begin slowly to reverse  $\mathfrak{H}$ . At first, the effects are slight; presently, however, instability begins, and, as the force is increased within a narrow range, we find the molecules all upset. This is followed by a stage of nearly elastic deflection as saturation is approached. Thus, the well-known general characteristics of cyclic processes are all reproduced in the model (see fig. 8 below).

Again, a small repeated cyclic change of  $\mathfrak{H}$  superposed upon a constant value of  $\mathfrak{H}$  produces small changes of aggregate polarity, which are reversible if the change of  $\mathfrak{H}$  is very small. This, as Lord Rayleigh has shown,\* is what happens in a magnetic metal,

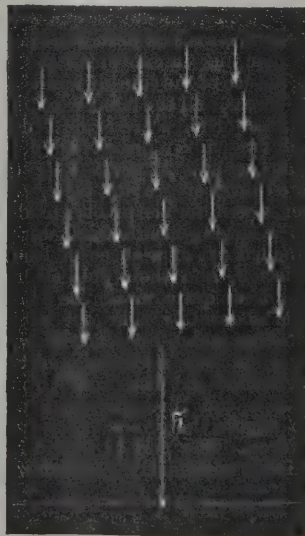


FIG. 6.

and the susceptibility with respect to small cyclic changes is small in the model, just as it is in the actual solid.

The chief facts of permeability and retentiveness, and hysteresis

\* Phil. Mag., March, 1887.

generally, are therefore at once explicable by supposing that Weber's molecular magnets are constrained by no other forces than those due to their own mutual magnetic attractions and repulsions. No arbitrary constraining forces are required. In the model the centres of rotation are fixed; in regard to the actual solid we may make an equivalent supposition, namely, that the distances between the molecular centres do not change (except in so far as they may be changed by strain).

Hysteresis, then, is not the result of any quasi-frictional resistance to molecular rotations; it occurs whenever a molecule turns from one stable position of rest to another through an unstable condition. When it is forced to return, it again passes through a condition of instability. This process, considered mechanically, is not reversible; the forces are different for the same displacement, going and coming, and there is dissipation of energy. In the model the energy thus expended sets the little bars swinging, and their swings take some time to subside. In the actual solid the energy which the molecular magnet loses as it swings through unstable positions generates eddy currents in surrounding matter. Let the magnets of the model be furnished with air-vanes to damp their swings, and the correspondence is complete.

A regular group of elementary magnets, especially when furnished with air-vanes, gives a good illustration of what has been called magnetic viscosity. When the imposed force  $\mathfrak{H}$  reaches a critical value one of the outer members of the group becomes unstable, and swings slowly round; its next neighbours, finding their stability weakened, follow suit, and the disturbance spreads through the group in a way eminently suggestive of those phenomena of time-lag in magnetisation which I have described in a former paper.\*

The model shows equally well other magnetic phenomena which presumably depend on the inertia of the molecules, such as the fact that a given force causes more magnetic induction when suddenly applied than when gradually applied, and leaves less residual magnetism when suddenly removed than when gradually removed.

The well-known effects of mechanical vibration in augmenting magnetic susceptibility and reducing retentiveness are readily explicable when we consider that vibration will cause periodic changes in the distances between molecular centres. This has not only a direct influence in making the molecular magnets respond more easily to changes of magnetic force by reducing their stability during the intervals when they recede from each other, but tends indirectly towards the same result by setting them swinging.

The effects of temperature which are common to the three magnetic metals may be stated thus:—Let any moderate magnetising force be applied, not strong enough to produce anything like an approach to magnetic saturation, and let the temperature be raised. Then the permeability *increases* until the temperature reaches a certain (high) critical value, at which, almost suddenly, there is an almost complete disappearance of magnetic equality. As regards the first effect, it is clear that an increase of permeability is to be expected from the theory; expansion with rise of temperature involves a separation of the molecular centres, and therefore a reduction of stability. As regards the almost sudden loss of susceptibility which occurs at a high temperature, it may do no harm to hazard a rather wild conjecture. We may suppose the molecular magnets to be swinging more or less, the violence of the swings increasing as the temperature rises, until finally it develops into rotation. Should this happen, all trace of polarity would of course disappear. The conjecture that the molecular magnets oscillate more and more as the temperature rises, is at least supported by the fact (carefully investigated by Hopkinson\* in iron and nickel; data for cobalt also have lately been supplied by du Bois†) that under strong magnetic forces rise of temperature reduces magnetism; for with strong forces the molecular magnets are already ranged so that their mean direction is nearly parallel to  $\mathfrak{H}$ : hence the earlier effect of heat (to diminish stability and facilitate alignment) does not tell, and the increased swinging simply results in reducing the mean value for each molecule of its moment resolved parallel to the magnetising force.

Before referring to effects of stress we may consider shortly the stability of a pair or line of magnets, treating each as a pair of poles subject to the law of inverse squares. Take first a single pair of equal magnets with centres at  $c$  and  $c'$  (fig. 7). The poles,  $p$ ,  $p'$ , would lie in the line  $c c'$ , but for the imposed force  $\mathfrak{H}$ , which produces a deflection,  $c c' p'$  or  $c' c p = \theta$ .

Let  $a$  be the angle which  $\mathfrak{H}$  makes with the line of centres,  $m$  the pole strength, and  $r$  the half length of the magnetic axis of each magnet. The deflecting moment is

$$2 \mathfrak{H} m r \sin (\alpha - \theta),$$

and the restoring moment is

$$\frac{m^2 c c N}{P P'^2},$$

$c N$  being drawn normal to  $P P'$ . The restoring moment at first increases with  $\theta$ , but passes a maximum at a value of  $\theta$  which depends on the relation of  $r$  to the distance between the centres. The condition of equilibrium is

$$2 \mathfrak{H} m r \sin (\alpha - \theta) = \frac{m^2 c c N}{P P'^2};$$

and as  $\mathfrak{H}$  and  $\theta$  are increased the equilibrium becomes neutral, that is to say, the condition of instability is reached, when

$$\frac{d}{d\theta} \{2 \mathfrak{H} m r \sin (\alpha - \theta)\} = \frac{d}{d\theta} \frac{m^2 c c N}{P P'^2}.$$

These two equations serve to determine the value of  $\mathfrak{H}$  and of  $\theta$  at which instability occurs. If we have to deal with a long line of magnets instead of a single pair, we have to write  $2 m^2$  instead of  $m^2$  in the restoring moment.

A considerable amount of stable deflection is possible when the distance between the poles is not small compared with  $r$ . When the direction of  $\mathfrak{H}$  is not much inclined to  $c c'$  (that is, when  $\alpha$  has a value approaching 0) there is no instability. In rows with various inclinations to  $\mathfrak{H}$ , the first to become unstable as  $\mathfrak{H}$  is increased will be that for which  $\alpha - \theta$  is equal to  $\frac{1}{2} \pi$ .

If  $a$ , the half distance between the poles in the undeflected position, be small compared with  $r$ , there is but little deflection before instability occurs, and in that case, provided  $a$  be not small, nor nearly equal to  $\pi$ , the occurrence of instability is defined by the condition

$$\frac{d}{d\theta} \frac{c N}{P P'^2} = 0,$$

which is satisfied when  $\tan \phi = \frac{1}{\sqrt{2}}$ ;  $\phi$  being the inclination of  $P P'$  to the line of centres. Hence, with the same proviso ( $a$  not nearly 0 or to  $\pi$ , and  $a$  small compared with  $r$ ), the value of  $\mathfrak{H}$  which causes the instability is

$$\mathfrak{H} = \frac{m}{12 \sqrt{3} \cdot a^2 \sin \alpha}$$

for a single pair of magnets, and twice this quantity for the middle members of a long row. This is, of course, least for magnets which lie normal to  $\mathfrak{H}$ .

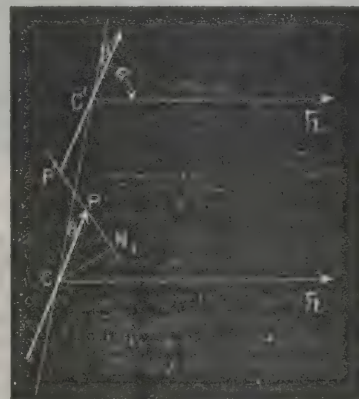


FIG. 7.

In the special case when  $\alpha = \pi$ , instability occurs when

$$\mathfrak{H} = \frac{m}{8 a^2}$$

with the single pair, or  $m/4 a^2$  with the row.

Applied to the case of a group of rows, uniform in distance between the centres, but various as regards their direction with respect to  $\mathfrak{H}$ , these considerations show that after  $\mathfrak{H}$  has reached a value sufficient to make the most susceptible members unstable, no very great increase is required to bring about instability in by far the greater number of the other rows. One general effect of increasing the distance between all the centres is to reduce the range of variation of  $\mathfrak{H}$  within which most of the different rows become unstable as the force is progressively increased.

In annealed metal, where we may expect considerable general homogeneity, as regards distance between the centres of the molecular magnets, we find that practically the whole of the abrupt stage in the process of magnetisation is included within narrow limits of magnetising force. We accordingly obtain curves like  $\Lambda$  (fig. 8).

When the metal is strained sufficiently to receive permanent set the curves take more rounded outlines (such as  $\Lambda B$ ), showing less susceptibility throughout, less residual magnetism, and more coercive force. The most natural explanation of this, on the basis of the molecular theory, appears to be that set produces on the whole a shortening of the distances between molecular centres, hence greater stability and more coercive force; but this is associated with heterogeneity, that is variety in the distances, hence the rounded outlines of the curves. We know that set tends to develop, or at least to emphasize, heterogeneity; for instance, a bar of iron or steel pulled in the testing machine stretches irregularly after the elastic limit is passed.

The effects of stress and consequent elastic strain on magnetic quality are so complex and so various in iron, nickel, and cobalt, that it would be premature to attempt any full discussion of them from the point of view of the theory now sketched. Only a few

\* "Roy. Soc. Proc.," June 1889.

\* "Phil. Trans.," 1889, A, p. 443; "Roy. Soc. Proc.," June, 1888.

† "Phil Mag.," April, 1890.

general features need be referred to at present. Some of these can be traced experimentally in the model by setting the supports of the magnets upon a sheet of thin India-rubber, which may be stretched or distorted to imitate the conditions of longitudinal or torsional strain.

When pulling stress is applied, those rows of molecular magnets which lie more or less along the direction of the stress, have their stability reduced by the lengthening of the lines of centres; similarly, rows which lie more or less normal to the stress have their stability increased. The resulting effect on the general susceptibility of the material will depend on which of these conflicting influences preponderates. Let pull be applied before magnetisation begins, while the metal is still in a neutral state. The stretching of longitudinal lines and the contraction of transverse lines will not only alter the stability of those molecules which continue to lie in their original rows, but will tend to make the members of those rows which are much lengthened swing round and form transverse lines in which they will be more stable than before. We may therefore reasonably expect that the permeability with regard to strong fields will be reduced by pull, as it actually is both in iron and in nickel, though with regard to weak fields the permeability may be increased, as it is in iron.

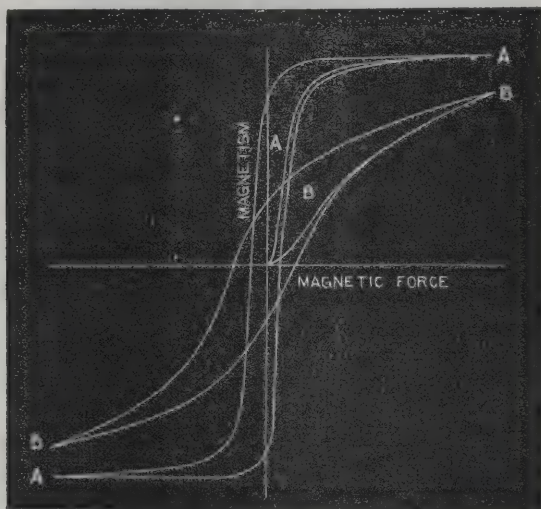


FIG. 8.

Again, the theory explains well why the effects of stress are by no means the same (1) when the stress is applied first and the magnetic force after, and (2) when the magnetic force is applied first and the stress after.

Let a moderate magnetising force be applied and then begin to apply stress. The first effects are in general large, for the strain precipitates into instability those molecular magnets which were already on the verge of instability. This is beautifully apparent in iron (see "Phil. Trans." 1885, part 2, plates 63 and 64); and the theory shows why the first effects are not reversible, why they do not disappear when the stress is removed, and why it is only in subsequent applications and removals of the stress that the magnetic changes become cyclic.

The same remark evidently applies to the first effects of stress on residual magnetism; also to the first effects of temperature-change either on induced or residual magnetism. Again, the theory shows that when a cyclic change of stress is repeated, there will be hysteresis in the corresponding changes of magnetism, whether induced or residual, unless either the cyclic range is very small or the magnetism approaches saturation. During each application of the stress, some molecular magnets will swing through unstable positions; during the removal of stress they will swing back, but not at the same values of stress. And it will be characteristic of this hysteresis that the variation in magnetism will begin slowly when the change from applying to removing stress, or from removing to applying stress, begins. All this agrees with the facts.

Moreover, the theory shows that even in the absence of any resultant magnetisation a cycle of stress makes the molecular configuration pass through a series of changes which will at first not be cyclic, but will become cyclic when the stress-cycle is repeated, and in which any intermediate value of the stress will be associated with different configurations during the going and coming parts of the process. In other words, we see that there will be hysteresis in the relation of molecular configuration to stress when a cycle of stress is repeated. Hence, certain rather obscure effects which have been observed in magnetic experiments; for instance, where an iron wire is loaded and partially unloaded down to a given load before being magnetised, its permeability is not the same as when the wire is completely unloaded and reloaded up to the same load. Experimental results of this kind led me in 1884 to write:—"If we apply and remove stress in a wire whose magnetic state is entirely neutral, we cause some kind of molecular displacement in the relation of which to the applied stress there is hysteresis."\* The

theory now offered shows how this happens. Hence, also, the remarkable hysteresis which the thermoelectric quality of iron exhibits with regard to cyclic changes of stress, discovered by Cohn, and more fully described in "Phil. Trans." 1886, p. 361. The hysteresis of molecular configuration with respect to stress has been proved to be removable or reducible by vibration.

From this theoretical explanation of hysteresis in the effects of stress, it at once follows that a cyclic change of stress (provided it be not very small) involves some dissipation of energy in a magnetic metal, whether the piece be magnetised or not. We may expect this dissipation to be most considerable under conditions which make the magnetic hysteresis large. But it will occur even when there is no external trace of magnetism.

This of course implies that, in a cyclic process of loading and unloading, work must be spent. There is no perfect elasticity in a magnetic metal, however slowly the process of straining be performed. Under any load there is less strain during application than during removal. This is borne out by experiments on the extension of iron wires (Brit. Assoc. Report, 1889, p. 502).

The same action occurs to a marked degree in torsional strains. In a twisted specimen there will be a tendency on the part of the molecular magnets to range themselves along lines agreeing more or less with the direction of maximum contraction. Alternate twisting to opposite sides should therefore cause much molecular swinging through unstable positions, with consequent dissipation of energy, even in a piece which is not magnetised.

Without going at present into details, it may be added that the phenomena of molecular "accommodation" studied by Wiedemann and by H. Tomlinson accord with the theory, and that it seems to lend itself well to explain the very remarkable results which have been obtained by Nagaoka\* in experiments with nickel wire under twist or under a combination of pull and twist. It also agrees with what little is known as to the influence that previous magnetisation in one direction has upon subsequent magnetisation in another direction.

To sum up, I have endeavoured to show:—

- (1) That in considering the magnetisation of iron and other magnetic metals to be caused by the turning of permanent molecular magnets, we may look simply to the magnetic forces which the molecular magnets exert on one another as the cause of their directional stability. There is no need to suppose the existence of any quasi-elastic directing force or of any quasi-fractional resistance to rotation.
- (2) That the intermolecular magnetic forces are sufficient to account for all the general characteristics of the process of magnetisation, including the variations of susceptibility which occur as the magnetising force is increased.
- (3) That the intermolecular magnetic forces are equally competent to account for the known facts of retentiveness and coercive force and the characteristics of cyclic magnetic processes.
- (4) That magnetic hysteresis and the dissipation of energy which hysteresis involves are due to molecular instability resulting from intermolecular magnetic actions, and are not due to anything in the nature of frictional resistance to the rotation of the molecular magnets.
- (5) That this theory is wide enough to admit explanation of the differences in magnetic quality which are shown by different substances or by the same substance in different states.
- (6) That it accounts in a general way for the known effects of vibration, of temperature, and of stress upon magnetic quality.
- (7) That in particular it accounts for the known fact that there is hysteresis in the relation of magnetism to stress.
- (8) That it further explains why there is, in magnetic metals, hysteresis in physical quality generally with respect to stress, apart from the existence of magnetisation.
- (9) That, in consequence, any (not very small) cycle of stress occurring in a magnetic metal involves dissipation of energy.

#### DISCUSSION.

Sir Wm. Thomson spoke of the extreme beauty and importance of the experiments shown by Prof. Ewing, and of the theory founded upon them. The fundamental idea of instability of the molecular magnetism seemed to be of very great importance indeed in explaining those puzzling phenomena which they had known in magnetic induction. The great amount of residual magnetism which Prof. Ewing himself showed to a higher degree than it had been shown before, was always one of the most difficult things to understand. But now that they saw an actual model in which those phenomena were produced, and in such an intelligible way, he thought that they might yet believe that the reality of the molecular constitution involved in a magnet was perfectly illustrated in that model. Who was to say that they had molecules pivoted round points? On the contrary, they were to believe more in the currents in cores theory, molecular currents. But they did not believe in magnetism as being merely translated from large models into a small scale to account for molecular phenomena. But he did say that if they had produced a model which illustrated any one part of the properties of matter, they had gone a certain distance towards explaining that property. What could be realised in steel and iron and wood and paper, was surely realisable in the wonderful and marvellous structure (let them not call it mechanism) of the molecule itself. They had numerous models to explain phenomena, but nothing he had seen had such

\* "Phil. Trans.," 1885, part ii., p. 614.

\* "Journal of the College of Science of the University of Tokio," vol. ii., 1888.

completeness as that they had been fortunate enough to see that day.

Mr. OSBORN REYNOLDS expressed his admiration for Prof. Ewing's work, and the happy discovery he had made of a simple process by which to illustrate a fact. Prof. Ewing said he thought friction had nothing to do with the phenomena of magnetism. But was Prof. Ewing prepared to say that that model had nothing to do with the explanation of friction just as it had to do with magnetism; and was there not a further step before them to explain friction by magnetism instead of magnetism by friction? It seemed to him that Professor Ewing had there an opportunity, not brought forward before in any way, of illustrating the action which for want of opportunity they lost. In an infinitely multiple system of positions of limited stability they had virtually a friction, and if they place it in any number of positions of limited stability it fell out of one to another. There they had it with very much more marked effect as regarded magnetisation.

Prof. FITZGERALD thought it would be very unfortunate if the general question were supposed to be confined merely to that of magnetisation.

Prof. EWING, in acknowledging the thanks of the section, said that for some years back he had been much impressed with the phenomenon, to which the name of hysteresis had been given, and as soon as this explanation of it occurred to him, it also seemed to him that the same thing had to be worked out in the way suggested by Prof. Reynolds and Prof. Fitzgerald as to friction.

Mr. MALLOCK (Torquay), said that Prof. Ewing had referred to the fact that there was a cyclic change in metals. He had experimented with many substances besides magnetic metals, and in only very few had he found anything like similarity between the first half the up side of the curve and the down side. Sapphire and topaz were very nearly the same, but he only noticed it in them.

## APPENDIX II.

### ON THE AIR CONDENSERS OF THE BRITISH ASSOCIATION.

By R. T. GLAZEBROOK (with a Note by Dr. A. MUIRHEAD).

(Presented in Section A, September 9th, in conjunction with the report of the Committee on Electrical Standards.)

THE question of issuing certificates of capacity has from time to time been discussed by the committee. The following paper gives an account of some experiments that have been in progress during the past two years with this object in view.

In the report for 1887 the committee express the opinion that it is desirable to proceed with the construction of an air condenser. In conformity with this opinion a meeting was held in London, at which Dr. A. Muirhead exhibited an air condenser consisting of a series of concentric brass cylinders insulated by glass rods, which appeared to the committee to possess great merits; and it was decided that the secretary should test this and two similar condensers which Dr. Muirhead offered to lend, before proceeding further with the construction of condensers for the Association. The tests were carried out with satisfactory results.

The capacity of each condenser was determined repeatedly, using the method of a vibrating commutator, due to Maxwell, already employed by J. J. Thomson, "Phil. Trans.," 1883, and Glazebrook, "Phil. Mag.," August, 1884. The values found were—

$C_1$	=	·0030514	microfarads.
$C_2$	=	·0031258	"
$C_3$	=	·0033288	"

It was found that the capacities remain constant from day to day, and that the accuracy of a single determination was about 1 in 1,000, although the capacity to be measured was so small.

A mica condenser belonging to the Cavendish Laboratory was compared with these—details of the method will be given shortly—and it was found that when comparing a condenser of 1 microfarad with the three air condensers combined, having thus a capacity of ·009506 microfarads, so that the ratio of the two was about 100 to 1, an accuracy of about 1 in 1,000 was attained. It was also shown that the capacity of the mica condensers as thus found, differed by nearly 2 per cent. from its value as determined by the rapid commutator, thus proving that the commutator method was unsuitable for a condenser showing absorption.

Thus for three mica condensers the following values were found:—

With commutator	By slow method of comparison.
·9690	·9868
·4934	·4994
·09543	·09644

These results make the necessity for an air standard all the more apparent. A report on the experiments, made up to that date, was laid before the committee at a meeting in London, in April, 1889. It was then decided to adopt Dr. Muirhead's form of condenser, and to have two made on the same pattern for the Association. These have been constructed by the Cambridge Scientific Instrument Company, following Dr. Muirhead's plan, but on an enlarged scale. Each has a capacity of about ·02

microfarads, or about six times that of one of the original condensers.

Fig. 1 shows the arrangement.

The condensers consist of 24 concentric tubes; the outer tube is about 2 feet 9 inches high and 6 inches in diameter. Each succeeding tube diminishes in diameter by half-an-inch; the tubes are about  $\frac{1}{32}$  inch in thickness, and the air space between the inside of one tube and the outside of the next is about  $\frac{1}{32}$  inch, but it was found impossible to get all the tubes of exactly the same thickness, so that in some cases the distance between the tubes is less than the above. These tubes are carried by two conical brass castings; the outside surface of each casting forms a series of twelve steps, over which the successive tubes fit. Each tube is held in position by screws. The upper cone is supported by the outside casing of the condenser, and twelve of the tubes hang vertically from it. The lower cone is carried by three ebonite pillars, about 3 inches in height; the twelve tubes which are attached to it come respectively between those which are suspended from the upper cone. Thus the insulation depends on the ebonite pillars, assuming there is no leakage across the air from the edges of the tubes. There is an opening in the outer casing, closed by a door, by means of which the ebonite can be cleaned; the whole is dried by placing inside a small vessel

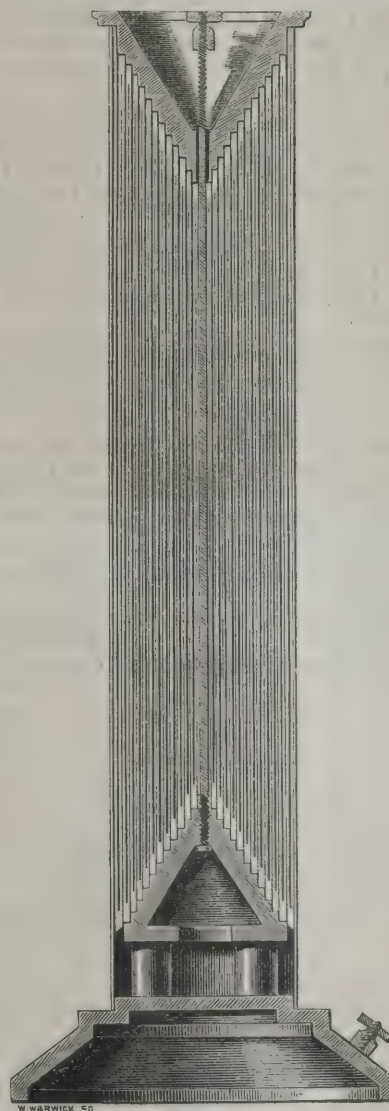


FIG. 1.

of sulphuric acid. In the centre of the upper cone there is a hole through which a rod passes. The rod is connected with the lower cone and forms the electrode for the insulated cylinders. An ebonite plug, fitting tightly round the rod, can be pushed down so as to close the hole and prevent the ingress of dust when the condensers are not in use; when they are being used the plug is removed.

The condensers are placed in the testing room at the Cavendish Laboratory and covered by a wood and canvas case to protect them from dust. It is not intended that they should be movable.

After this description of the condensers we will proceed to an account of the tests to which they have been subject. The first test was for leakage.

One set of cylinders was put to the earth while the other was connected with a gold leaf electroscope. An attempt was then made to charge them with an electrophorus or a small electrical machine, but this failed entirely. The electricity either sparked across at places where the tubes were very close together, or

before the potential rose sufficiently to affect the electroscope small fibres or dust particles which adhered to the tubes formed leaks across; it was clear that the condenser could not be charged to the potential of the machine. Tests were then applied for leakage when the potential was lower. One set of tubes were connected to one pole of a battery—about 36 storage cells were generally employed, having an E.M.F. of 75 volts—the other set being in connection with an insulated key, the second pole of the battery was connected through a galvanometer to the key and the condenser charged. After an interval, usually about 5 minutes, contact was again made at the key, the deflection of the galvanometer needle—assuming the E.M.F. of the battery not to have changed—was a measure of the quantity of electricity which had leaked from the condensers in the five minutes.

The amount of leakage was very different in the two condensers and depended greatly on the dryness of the air and ebonite pillars. Thus on March 11th, when strong acid had been enclosed for some time, for condenser I. the leak per 1 minute amounted to about .1 per cent. of the whole charge, while with condenser II. it was about 10 times as great.

The sulphuric acid was removed during the Easter vacation and replaced by calcium chloride and after this the leak in I. rose to about 1. per cent. per minute or 10 times its former value, while that in II. was from 3 to 4 per cent. of the charge. With the calcium chloride inside the leak was never reduced to less than about .8 per cent. per minute. In August the condensers having been closed since June with calcium chloride there was a leak in I. of about 3 per cent. per minute, while in the same time II. lost about 8 per cent. of its charge.

On August 14th, immediately after this test, the calcium chloride was replaced by sulphuric acid, and the leak was quickly reduced to about 1 per cent. per minute for I. For II., no improvement showed itself at once. The next day the leak in I. was about .4 per cent. per minute, that in II. had not been greatly reduced. On August 16th the ebonite was, therefore, well cleaned, and air was blown through the tubes of II., and the whole closed for about two hours; the leak had then fallen to about 2 per cent. per minute. By August 18th, the leaks were still more reduced, that in I. being .2 per cent. per minute, while that in II. was .6 per cent. per minute.

By the afternoon of this day, the upper parts of the condensers having been open to the air of the laboratory for some six hours during other tests, the leaks had appreciably increased, but they had fallen again the next day when the condensers were left closed during the night.

Thus, during the observations in August, with the exception of those on August 14th, the condenser I. was losing its charge at the rate of about  $\frac{1}{100}$ th part per 1 minute, while the leakage in II. was some five or six times as great, being about  $\frac{1}{10}$ th part of the charge per 1 minute.

As will be seen later, several mica condensers were compared with I. and II., the leaks in them were all small, and did not exceed more than  $\frac{1}{500}$ th per minute.

We come now to the experiments for determining the capacities of the two condensers. Of these, three independent series were made, viz., in December, 1889, May and June, 1890, and August, 1890.

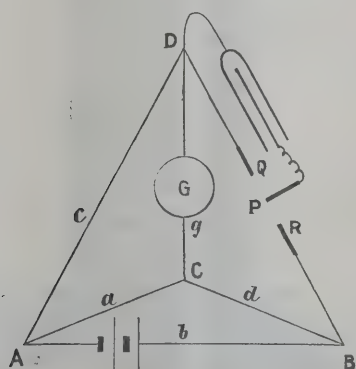


FIG. 2.

The method, already referred to, was used. Fig. 2 gives a diagram of the method; in fig. 3, the connexions actually employed are shown. With the notation employed, *Phil. Mag.*, August, 1884.

We have, if *c* be the capacity of the condenser, *n* the number of times it is charged per 1 second,

$$nc = \frac{a \left\{ 1 - \frac{a^2}{(a+c+g)(a+b+d)} \right\}}{c d \left\{ 1 + \frac{a g}{c(a+b+d)} \right\} \left\{ 1 + \frac{a g}{d(a+c+g)} \right\}}$$

In most of the experiments about to be described, we had the following values in legal ohms:—

$$a = 10 \quad d = 1,000 \\ b = 18 \quad g = 17,600$$

while *c*, which was the adjustable arm, varied from 6,000 to 15,000.

With these values, the only correction which need be included, is the last factor in the denominator, and we may write

$$nc = \frac{a}{c d \left\{ 1 + \frac{a g}{d(a+c+g)} \right\}}$$

The resistances were taken from a legal ohm box belonging to the laboratory; the various coils in this box were carefully compared with each other by Mr. Searle, and found to be consistent with each other, at any rate to within 1 in 10,000. The coils were also compared with the standards of the Association, and it was found that at 16° they were greater than legal ohms in the ratio of 1.0011 to 1. The standard temperature adopted in the experiments was 17°, and since the coefficient of increase of resistance of the box is about .0003 per 1° C., the resistances require to be multiplied by 1.0014, to reduce them to legal ohms. In some cases, in the value of *c*, coils from a B.A. unit box, containing coils of ten, twenty, thirty and forty thousand, B.A. units were employed.

The values found for these coils by myself in terms of the legal ohm box showed that they were very consistent with each other, and that the nominal 10,000 B.A.U. was equal to 9,880 legal ohms as measured by the legal ohm box.

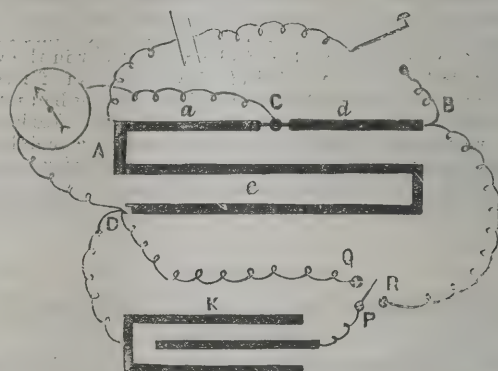


FIG. 3.

In the comparisons of two condensers certain coils from a megohm box were used; the value of each of these was also determined. They were as follows:—

1	...	98,731	Legal ohms of standard box.
2	...	98,625	" "
3	...	98,698	" "
4	...	98,735	" "
9	...	98,725	" "
10	...	98,776	" "

In the experiments on Dr. Muirhead's condensers, the vibrating commutator described in Prof. Thomson's paper, "*Phil. Trans.*,"

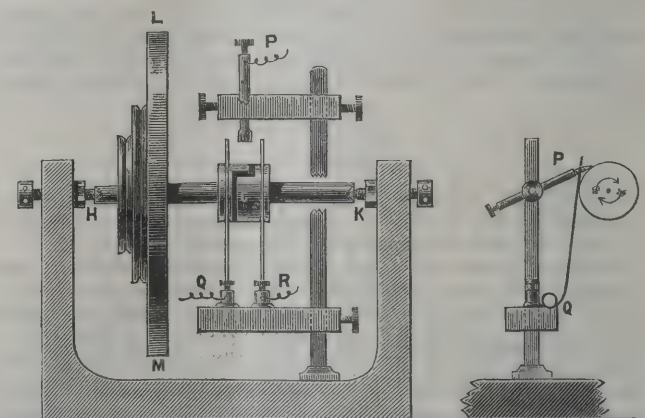


FIG. 4.

1883, or in my paper, "*Phil. Mag.*," 1884 was used, and that with complete success. In the experiments about to be described, this was replaced by a rotating commutator which had been fitted up by Prof. Thomson and Mr. Searle for their experiments on the other value of "*v*," and which possesses certain advantages over the other form. Dr. Muirhead and Dr. Fleming have also used a somewhat similar arrangement of apparatus. Fig. 4 shows the arrangement. The split ring commutator is carried on the axle, *h k*, which is driven by a water motor. Two wire springs, *q, r*, are in contact with the two halves of the commutator respectively, and as it rotates the brush, *p*, made of very fine brass wire, is brought into communication alternately with *q* and *r*. The disc, *L, M*, was of iron, and its mass helped to steady the motion. On one face of the disc a series of circles were drawn forming a number of annuli. The successive annuli were divided each into a different number of divisions by radial marks. Thus in the innermost annulus there were four on the next five, and so on.

The disc, as it rotated, was watched in the usual stroboscopic manner through two slits on two pieces of thin metal carried by the prongs of a tuning fork, which made about 64 vibrations per second.

When the frequencies of the disc and of the fork were in certain simple ratios to each other, the corresponding pattern on the disc was seen in a steady position. The driving pulley of the motor carried a second band, which passed over an idle pulley near the observer at the tuning fork, and the speed of the motor and hence of the disc was adjusted partly by varying the flow of water, partly by friction on this band until the desired pattern was seen in the steady position; this position was easily maintained by varying the friction on the string. The tuning fork drove a second fork an octave above itself in frequency. This fork was mounted near the standard fork of the Laboratory, and the beats between the two were counted. The frequency of the standard fork was determined by Prof. Thomson and Mr. Searle for their experiments on "v" recently communicated to the Royal Society. They found that it had changed slightly since it was determined by Lord Rayleigh, and give as the result of their experiments. Frequency at temperature  $t^{\circ}$

= 128.105 { 1 - (t - 16) .00011 }

The driven fork was always adjusted to a slightly lower frequency than that of the standard, so that there were about 20 beats to the minute between the two. During any series of observations 10 beats were repeatedly counted, but they rarely varied during the series sufficiently to affect the result. The commutator was designed and partly constructed by Mr. Searle, who observed at the tuning fork throughout. A little attention was required to secure good contact between the springs, q, r, and the rotating parts, and also to adjust the brush, p, but with moderate care in the adjustments the apparatus worked perfectly.

The galvanometer was one constructed in the laboratory; it had a resistance of 17,600 ohms, with a long silk fibre suspension—a quartz fibre would have been an improvement.

Its sensitiveness was such that 1 scale division corresponded to  $.83 \times 10^{-10}$  C.G.S. units of current; the time of swing was 7.2 seconds, so that the sudden discharge through the galvanometer of  $10^{-10}$  C.G.S. units of electricity produced a throw of one division, or, in other words, the quantity which, when discharged suddenly through, gave a throw of 8 divisions was  $8 \times 10^{-10}$ . This was determined by discharging through the galvanometer a condenser of capacity .1 microfarad when charged to 1 volt, the throw observed was 100 divisions, while the steady current due to an E.M.F. of .001 volt produced a deflection of 72 divisions.

The observations were made by varying c. There was a commutator in the battery circuit; in each position of this commutator two values of c were taken and the corresponding resting points of the spot on the scale observed. From these the value of c, which corresponded to the zero position of the spot, was obtained by interpolation.

These observations were made twice for each position of the commutator and the mean taken.

We will give one series as an example :—

August 27th, 1890.  
Temperature of standard fork 18.8°  
Beats ... .. 20 in 65.4 sec.  
" ... .. 20 in 65.2 sec.

CONDENSER No. I.  
Frequency, 80 approximately.

Position of Commutator.	Zero reading.	Resistance.	Resting point.
/	48	{ 5890	47
		{ 5880	51
\	48	{ 5880	46
		{ 5890	49
/	48	{ 5890	48
		{ 5880	51
\	49	{ 5880	46
		{ 5890	50

Temperature of coils 17.5°.  
Beats 20 in 64.8 at 19.3°.

It will be seen that between the third and fourth series the galvanometer zero has shifted slightly.

From these we get as the four values of c, the following :

5887.5  
5886.6  
5888.3  
5887.5

Mean 5887.5 at 17.5°  
Correction to 17° .9

Value c = 5888.4 at 17°

while the beats are 20 in 65 seconds at 19° or .307 per 1 second; at 19° the frequency of the standard is 128.066, thus the frequency of the driven fork is 128.066 - .307, i.e. 127.759. Thus for the driving fork we have the octave below this or 63.879, while the frequency of the commutator is 5/4 of this.

Hence in this series

$n = 79.849$   $c = 5888.4$

The accuracy attained in this series is a fair specimen of the whole. With these explanations we proceed to give the results in tabular form, showing the date, the values of n and c, and the resulting value of c. The wire by which the condenser was connected to the commutator together with the commutator itself, had a certain capacity which was determined in the same way, merely disconnecting the wire from the condenser. In the observations in December and June we found

$a = 10$   $d = 98730$   $c = 28460$   $n = 63.9$

whence the capacity of the wires is .0000625 microfarads, while in August after the apparatus had been set up afresh in a different position with new connecting wires, the value of c was 22,200 and the capacity .0000799 microfarads; for the wires the values of c could be determined to about 1 per cent.

In the table the value of c has been corrected for the capacity of the wires.

TABLE I.—CONDENSER I.

Date.	Value c.	Value n.	c, in microfarads.	Mean of series.
Dec. 31st, 1889 ...	14,762.5	31.95	.021025	.021020
	7,372.3	63.90	.021016	
	5,894.3	79.875	.021019	
May 20th, 1890 ...	14,772.9	31.93	.021023	.021022
	7,376.5	63.86	.021017	
	5,896.4	79.825	.021025	
June 16th, 1890...	7,375.0	63.86	.021022	.021022
Aug. 27th, 1890 ...	14,745.9	31.939	.021038	.021032
	7,364.8	63.879	.021027	
	5,888.4	79.849	.021030	

Mean of the whole, .021024 microfarads.

TABLE II.—CONDENSER II.

Date.	Value c.	Value n.	c, in microfarads.	Mean of series.
Dec. 31st, 1889 ...	13,957.4	31.95	.022238	.022237
	6,963.6	63.90	.022249	
	5,575.1	79.875	.022225	
May 20th, 1890 ...	13,945.3	31.93	.022271	.022273
	6,957.4	63.86	.022283	
	5,568.2	79.825	.022266	
June 16th, 1890 ...	6,953.4	63.86	.022296	.022296
Aug. 27th, 1890 ...	13,774.6	31.939	.022523	.022519
	6,878.6	63.879	.022515	
	5,500.4	79.849	.022518	
Aug. 28th, 1890 ...	6,878.6	63.881	.022515	.022515

TABLE III., giving the capacity of two Mica condensers for various frequencies of charge.

CONDENSER A.

Frequency.	June 12.	June 14.	June 16.	Mean.
21	.04885	.04886	...	.04886
32	.04883	.04884	...	.04884
64	.04868	.04868	.04864	.04867
80	...	.04859	...	.04859

CONDENSER B.

21	...	.09642	...	.09642
32	...	.09642	...	.09642
64	...	.09634	.09642	.09638

Taking the air condensers first the tables show that at any rate for frequencies between 32 and 80 per second, the time of charging has no effect on the capacity, while the individual observations in each series are within 1 in 2,000 of each other.

For condenser I. the observations at frequency 64 are in all the series the least, but this is not the case with condenser II.

The capacity of condenser I. shows no change between December 1889 and June 1890. The observations in August 1890 are all rather greater than the earlier series but the increase about 1 in

2,000 is almost within the error of the experiments. With regard to condenser II. there is an indication of a rise in its capacity all through. It will be remembered that we have already shown that the insulation resistance of II. is considerably less than that of I. but it is easy to see that this leak was not sufficient to account for the change, for if  $R$  be the resistance of the leak, then our approximate formula becomes

$$n c + \frac{1}{R} = \frac{a}{c d} \text{ instead of } n c = \frac{a}{c d}$$

Now the current through the condenser when leaking most was about  $\cdot 0002 \text{ E c}$ , where  $E$  is the E.M.F. to which it is charged and  $c$  the capacity of the condenser.

Thus the resistance of the leak is  $\frac{1}{\cdot 0002 \times c}$  or  $\cdot 25 \times 10^{21} \text{ C.G.S. units}$ , since the value of  $c$  is  $\cdot 02 \times 10^{-15}$ . This resistance is 250,000 megohms.

Hence the correction to the capacity  $= 1/n R = \cdot 0002 \times c/n$ , and this is far too small to affect us.

There is no doubt then that the capacity of II. altered during the experiments by about 1 per cent. and it will be necessary to take it to pieces and set it up again.

It will be remembered that, in the early part of August, the leak in II. was very great, and it seems probable that the steps taken to discover the cause of the leak have produced a change in capacity. The experiments on II. then serve merely to show that the capacity can be found by the rotating commutator method to a high degree of accuracy, while those on I. prove that an air condenser, of  $\cdot 02$  microfarad capacity, has been constructed, which has retained its capacity, unaltered, for the eight months between January, 1889, and August, 1890.

The effect of the leak in condenser II., was still further investigated on August 28th. The plates of II. were connected by a resistance of 30 megohms. Hence the correction to  $c$ , which is

$$- \frac{1}{n R}, \text{ becomes } - \cdot 000520 \times 10^{-15}, \text{ when } n = 64.$$

The value of  $c$  found with the leak in was  $\cdot 023813 \times 10^{-15}$ .

Hence, making the correction,  $c = \cdot 02249$  microfarads, which is sufficiently close to the value found without the artificial leak.

Table III. shows that with mica condensers not very much greater in separate capacity than the air condensers, a change in the frequency of the charge from 21 to 80, produces an appreciable change in the capacity; this, of course, is in consequence of the absorption. With large condensers, as we have already seen, the effect is more marked.

It remains then to give an account of the experiments undertaken for the purpose of comparing mica or paraffin condensers, as ordinarily used with the air condensers, and of investigating some of the effects of absorption.

The two well-known methods of De Sauty and Sir William Thomson have both been employed.

The arrangements are shown in figs. 5 and 6.

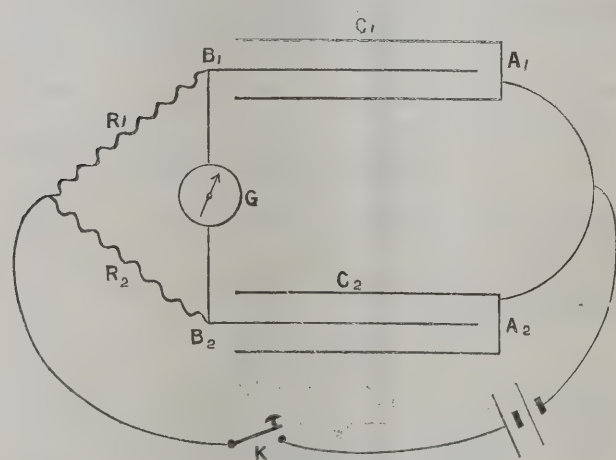


FIG. 5.

The first of these is not really suitable for use in cases in which there is absorption, though with care a fairly accurate measure of the instantaneous capacity can be found. The resistances,  $R_1, R_2$ , can always be arranged so that the effect of the charge rushing into the air condenser shows itself, as a sharp kick of the spot of light—to the left, say—followed by a slower deflection in the other direction due to the absorption charge soaking into the mica or paraffin. The resistance for which this sharp kick practically disappears is fairly definite, and from it the instantaneous capacity can be found, while an observation of the resulting kick due to the absorption enables us to calculate the increase of capacity which arises from that cause. This can be done in various ways; the simplest, perhaps, is to disconnect the condensers from the circuit, and replacing the mica condenser by a variable condenser of small capacity, observe the kick this produces in the galvanometer when charged with the same battery. From this the capacity to which the absorption is equivalent can be approximately calculated.

Thus a condenser of about  $\cdot 1$  microfarad was compared with

Dr. Muirhead's three condensers combined. Taking  $c_2, R_2$  to refer to the air condenser, we had

$$c_2 = \cdot 009506 \\ R_2 = 893650 \text{ ohms.}$$

and with  $R_1 = 89300$  there was a slight tremor to the left and a movement of three divisions to the right; on changing  $R_1$  by 100 ohms the change in the motion of the spot was marked.

This gives for the instantaneous capacity  $c_1 = \cdot 09550$ , the value found by the commutator at frequency 64 was  $\cdot 09543$  microfarads.

To evaluate the 5 divisions the air condenser was disconnected and the mica condenser replaced by one of capacity  $\cdot 001$  microfarads; the kick observed was 4.8 divisions, while with  $\cdot 002$  microfarads it was 9 divisions, thus a kick of 5 divisions corresponds to about  $\cdot 0011$  microfarad capacity. Hence the capacity of the mica condenser, including the full effect of absorption, is  $\cdot 0966$  microfarads.

The second method, about to be described, in which the absorption effect is included, gave  $\cdot 0965$  microfarads.

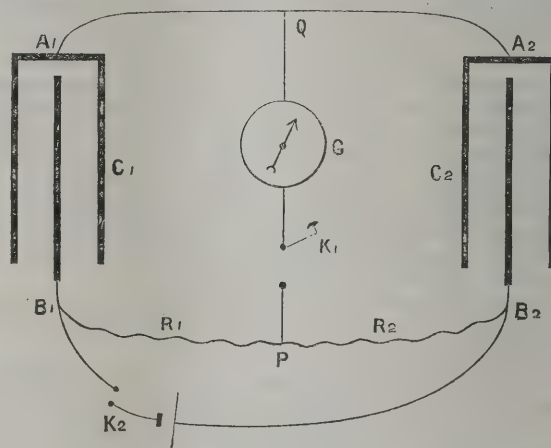


FIG. 6.

Let us now consider the second method. The current from a battery flows through a large resistance,  $R_1 + R_2, B_1 \text{ P } B_2$  (fig. 6). One plate of each condenser is in contact with  $B_1$  and  $B_2$  respectively, let  $v_1, v_2$  be the potentials at these points. The other plates,  $A_1, A_2$ , are insulated and connected together and to the galvanometer  $G$ , the other pole of the galvanometer can be connected to  $P$ , through the insulated key  $K_1$ . The galvanometer can be replaced by an electrometer. Let  $r_1$  be the resistance,  $P, B_1, B_2$  the resistance,  $P, B_2$ . Suppose the point,  $P$ , be put to earth, the rest of the circuit being insulated. Then if  $c_1, c_2$ , be the capacities it is easy to see that there will be no current through the galvanometer on making the key  $K_1$ , if  $c_1 R_1 = c_2 R_2$ .

Now in the case of a mica or paraffin condenser the capacity is a function of the immediate past history of the condenser and different values will be found for the  $R_1, R_2$ , according to the time the charging has lasted. Dr. Muirhead, however, who uses the method largely has shown how to obtain the instantaneous capacity from the observations. His method is described in the following extract from a letter to myself.\* In the method as described, one pole of the battery is to earth instead of the point  $P$  of fig. 6.

Dr. Muirhead writes:—"I have  $\cdot 05$  microfarad nearly in air condensers, and a series of mica condensers of  $\cdot 1, \cdot 2, \cdot 3, \cdot 331$  (original  $1/3$ ) and  $\cdot 498$  (original  $\cdot 5$ ) mf. capacity, all enclosed in a double air-tight box to keep the temperature as uniform as possible. The capacity of these standards is determined periodically by both the tuning fork method (using a revolving com-

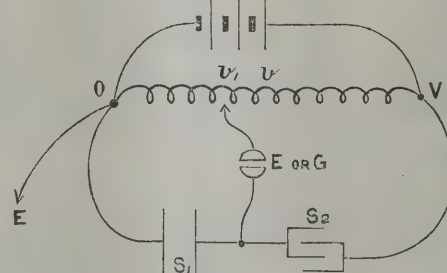


FIG. a.

mutator instead of the tuning fork), and by the ballistic galvanometer method. One can make comparison of these condensers among themselves and with other condensers by the method I adopt to an accuracy of 4 in 10,000. The temperature coefficient of shellacked mica condensers is about  $\cdot 018$  per degree centigrade and of paraffined mica  $\cdot 034$  per cent.

Let  $s_1$  be the capacity of the air condensers  
"  $s_2$  " " " " condenser to be compared with air  
condensers.

\* See also *Electrician*, September 5th, 1890.

After making battery contact, supposing the charging of the condensers to be instantaneous and the absorption nil, then we have

$$v s_1 = (v - v_1) s_2$$

where  $v$  is the potential of the junction of the two condensers. Should there be any delay in obtaining the balance, the position of  $v$  on the slides will vary—say to  $v_1$ —then the charges on the two condensers will be

$$v_1 s_1 \text{ and } (v - v_1) (s_2 + \sigma)$$

respectively where  $\sigma$  is the apparent increase of capacity of  $s_2$  due to absorption or soaking in of charge. On disconnecting the armature of  $s_2$  from the slides and putting it to  $o$ , or earth,

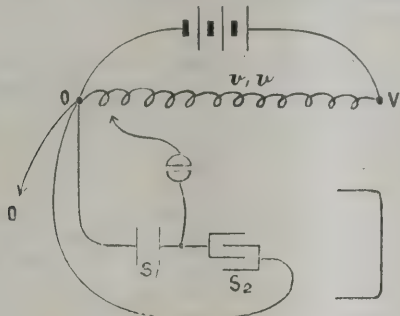


FIG. b.

the potential falls from  $v$  to  $o$ , and immediately afterwards the potential of the junction of the two condensers becomes, say,  $v_2$ , so that

$$s_1 v_1 + s_2 (v_1 - v) = (s_1 + s_2) v_2$$

Hence

$$v_1 (s_1 + s_2) - v s_2 = (s_1 + s_2) v_2$$

or

$$s_2 = s_1 \frac{v_1 - v_2}{v - (v_1 - v_2)}$$

$v$  and  $v_1$  are known, and  $v_2$  is indicated at once on an electrometer, or when a galvanometer is used it can be measured quickly thus:—As soon as  $v_1$  has been observed, break the galvanometer contact and move the index of the slides down to  $o$ , then directly after bringing the armature of  $s_2$  from the full potential of the slides to zero, close the galvanometer circuit and observe the throw,  $\alpha$ , which is a measure of  $v_2$ , the potential of the junction of the two condensers."

In my own experiments, which were made after consultation with Dr. Muirhead, I adopted a method practically the same as his; but before describing it, it will be better to consider rather more the effects of absorption. Let us suppose, at first, that the leakage from either condenser is inappreciable. If there be no absorption, each condenser is charged to its full potential practically instantaneously, and it does not matter when or in what order the keys,  $\kappa_1 \kappa_2$ , are put down, the position of  $p$  on the slide is not affected.

Suppose, now, that  $c_1$  shows absorption, the capacity increases with the time of charging. We can get the instantaneous capacity by depressing, first, the key  $\kappa_1$  and then  $\kappa_2$ , but in this case we are troubled with the effect of the slow after charging as in the other method. Still the resistance, for which the kick due to the initial charging disappears, is, with the condensers I employed, fairly marked, and a value for the instantaneous capacity can be thus fairly accurately obtained.

If, now,  $\kappa_2$  be made for 1 second and then  $\kappa_1$  depressed, a different position will be found for  $p$ . With this interval of charge the apparent capacity differs appreciably from its instantaneous value, and the after effects of the absorption can still be observed. The same is true for intervals of 2, 3 or 4 seconds, the value obtained for the capacity increases, and the after effect is still noticeable; but with the condensers and battery I used, if the time of charging was prolonged to 5 seconds, the after effect was inappreciable, and the position of  $p$  on the slide, and hence the apparent value of the capacity, were hardly affected by further increasing the time of charge. In the experiments on a cable recorded in Dr. Muirhead's paper already referred to, the absorption effects continue much longer. In the observations recorded below, then, unless the contrary is stated, the key,  $\kappa_2$ , was held down for 5 seconds, and then,  $\kappa_1$  being depressed, the position of  $p$  determined, for which the galvanometer remained unaffected. The value of the capacity deduced, then, is the full capacity for the potential to which the condenser is charged. It is of course possible, though further experiments would be wanted to prove it, that the full effect of absorption is not merely to increase by a definite amount, independent of the potential, the apparent instantaneous capacity, but that the increase may depend on the potential to which in each case the condenser is being charged. It will of course depend on the purposes for which the condenser is to be used whether the instantaneous capacity or the full capacity is required, and it probably will be best, when issuing certificates, to state both the instantaneous capacity and the maximum increase due to absorption—mentioning at the same time the potential used in the experiments for determining this correction, and also the time of charging in which this maximum increase is practically attained.

The method I employed in determining the correction due to absorption was the following:—Suppose the plates,  $A_1 A_2$ , to be at potential zero and uncharged. Make the battery key,  $\kappa_2$ , and after keeping it made for some little time break it again. If there be no absorption  $A_1$  and  $A_2$  will still be at zero potential and uncharged; but let there be absorption in one of the two,  $A_1$ , and let  $B_1$  be the positive pole of the battery; then, while the battery is on, negative electricity is being absorbed by the dielectric near  $A_1$ , and positive electricity is left free over the plates,  $A_1 A_2$ , and the wires connecting them. When the battery is broken the negative electricity begins to soak out, but the process takes time. Hence, if immediately on breaking the battery key,  $\kappa_2$ , the galvanometer key,  $\kappa_1$ , is made for an instant, there is a throw of the galvanometer needle indicating the passage to the earth of the positive set free by the absorption. If, after a time, the galvanometer key be again depressed, there is an equal throw in the opposite direction caused by the passage of the negative which has again soaked out of the condenser. The required correction is obtained from either of these throws.

For, let  $i$  be the current between  $B_1$  and  $B_2$ ; let  $c_1$  be the instantaneous capacity of the one condenser and  $c_2$  of the other; and let  $q$  be the quantity of electricity absorbed. Then the quantity of negative electricity on the plate,  $A_1$ , is  $c_1 R_1 i + q$ , and the quantity of positive electricity on the plate,  $A_2$ , is  $c_2 R_2 i$ , if we assume the potential of these plates to be still zero.

Therefore,

$$c_1 R_1 i + q = c_2 R_2 i$$

$$\therefore \frac{c_1}{c_2} = \frac{R_2}{R_1} - \frac{q}{c_2 R_1 i}$$

Then neglecting the battery resistance

$$i = \frac{E}{R_1 + R_2}$$

If  $E$  be the E.M.F. of the battery.

$$\therefore \frac{c_1}{c_2} = \frac{R_2}{R_1} - \frac{q}{c_2 E} \left( 1 + \frac{R_2}{R_1} \right)$$

Now, we have seen that with the galvanometer as I used it, if  $g$  is the throw produced by the passage of a quantity  $q$ , then  $q = 8 \times 10^{-10}$ .

The battery consisted of 36 small storage cells, which, when fully charged, had an E.M.F. of about 75 volts, so that

$$E = 75 \times 10^8.$$

Also,

$$c_2 = .021 \text{ microfarads} \\ = 21 \times 10^{-18}.$$

Hence, with these numbers,

$$\frac{c_1}{c_2} = \frac{R_2}{R_1} - \frac{8}{1575} \left( 1 + \frac{R_2}{R_1} \right)$$

Or, writing it as a correction to  $c_1$ ,

$$c_1 = \frac{c_2 R_2}{R_1} - \frac{8}{75} \left( 1 + \frac{R_2}{R_1} \right) 10^{-18}.$$

Examples of the method of applying this correction will be given shortly.

It will be noticed that a leak in one of the condensers may be corrected for in the same way. For, suppose the mica condenser to leak, then a quantity of  $q'$  of positive electricity passes through to the plate,  $A_1$ , while the battery current is on, and the condition that the galvanometer should not be deflected is,

$$c_2 R_2 i - c_1 R_1 i = q',$$

the same equation as previously.

There will, however, be this difference: on depressing the key,  $\kappa_1$ , after breaking the battery circuit, a positive charge will in both cases pass from  $A$  to  $B$  through the galvanometer; if this charge be due to absorption, there will, when the key is again depressed after an interval, be a current through the galvanometer in the opposite direction; while if the first charge be due entirely to a leak, there will be no effect when the key is the second time depressed. In practice, the leak and the absorption may exist together either in the same or different condensers. In the second case the leak will tend to produce opposite effects to those caused by the absorption; the quantity,  $q'$ , however, increases nearly in the ratio of the time of charging, while  $q$  increases for the first few seconds, but soon reaches a maximum and then remains constant.

These considerations are illustrated by some experiments in which the condensers I. and II. were compared with various mica condensers. The battery key was in each case made for 30 seconds; it was then broken, and the galvanometer key was made for an instant, the resulting throw was the sum of those due to (1) the leak in the mica condenser ( $\lambda$ ) say; (2) the absorption in that condenser ( $\alpha$ ) say; and (3) the leak in the air condenser, which produces an effect in the opposite direction  $-\lambda'$ , say.

After about 30 seconds more the key was again depressed, the resulting throw is due to the absorbed electricity which has again leaked out, and will give us  $-\alpha$ .

The following table gives the results; each observation entered is the mean of three or four.

TABLE.

Condenser compared with standard.	—	I.	II.
·05	$\lambda + a - \lambda^1$ — $a$	2·3 — 3	— 7·3 — 2·6
·1	$\lambda + a - \lambda^1$ — $a$	2·2 — 3	— 9 — 3
·1	$\lambda + a - \lambda^1$ — $a$	2·2 — 2·2	— 7 — 3·5
·5	$\gamma + a - \lambda^1$ — $a$	3·3 — 3·3	— 4 — 2·5
·1	$\lambda + a - \lambda^1$ — $a$	4 — 5	— 3·2 — 5·7

If we take the comparisons with condenser I. first, it appears that throughout  $\lambda - \lambda^1$  is small. For the ·05 and ·1 microfarad it may be about — ·5 divisions, while  $a$  is about 3 divisions; for the ·5 microfarad,  $a$  is rather larger being about 3·3 and  $\lambda - \lambda^1$  is zero, while for the 1 microfarad  $a$  the absorption effect is distinctly larger, being 5 divisions, and  $\lambda - \lambda^1$  is about — 1. All this is of course quite consistent with the fact that condenser I. and the mica condensers insulate well while there is absorption by the mica.

When, however, we come to the condenser II. the results are quite different. While the absorption effects are comparable, as of course they ought to be, with those obtained in the comparison with I. the leakage effects are very large.

The values of  $\lambda - \lambda^1$  in order are as follows, —9, —12, —10·5, —6·5, —8. Now we know that the mica condenser shows very little leak effect, the above leaks are therefore almost entirely in the air condenser II. If we suppose the total leak to be proportional to the time, then for the 5-second charges used in the experiments the corresponding values of  $\gamma$  in the corrections to be introduced for leakage will be 1/6 of the above, and thus we get the following results:—

Condensers.	Value of $\gamma$ .	Correction to capacity in microfarads for the leak.
·05	1·5	·00007
·1	2	·00016
·5	1	·0003
1·0	1	·0007

It is clear that the corrections are in all cases small, being not much over 1 in 1,000, but they serve to illustrate the method. The above corrections are only those for the leak, the correction for absorption could be found in the same way.

With a view to testing the method in a case in which a leak only existed without absorption, a number of comparisons of I. and II. were made.

In these experiments the resistance with I. was 296,240. The resistances with II. and the deflections due to the leak obtained by breaking the battery and then making the galvanometer, are given below together with the ratio of the two capacities corrected for the leak.

Interval between battery and galvanometer contacts.	Resistance.	Leak in scale divisions.	$\frac{R_1}{R_2}$	Correction.	$\frac{C_2}{C_1}$
0"	275,980	0	1·0734	0	1·0734
5"	275,180	2·5	1·0765	—·0032	1·0733
30"	271,380	14·5	1·0916	—·0184	1·0732
60"	267,180	22·5	1·1088	—·0286	1·0802
5"	91,370	5	4·3223	·0168	4·3391
30"	92,670	22	4·2617	·0743	4·3360
60"	94,170	42	4·1938	·1415	4·3353

The last three lines of the table give the results of a series of comparisons between II., which had a leak, and a condenser of ·1 microfarad, which showed absorption. The resistance with II. was 394,930 ohms.

In the first four lines the corrections are negative for the capacity of the leaky condenser is being found in terms of the standard. In the next three lines they are positive, for the ratio of the mica condenser to the leaky standard II., is being found.

A comparison of the fourth and sixth columns shows the results of the correction. In the fourth line it is clear that the correction is not large enough. This probably arises from the difficulty of making contact with the galvanometer circuit sufficiently soon after the battery is broken to ensure that the whole of the charge accumulated by the leak should pass through the galvanometer.

The leak correction was also tested with similar results by putting an artificial leak in I.

We will now give some specimens of the observations made to compare I. with a mica condenser in order to show the accuracy attained. Condenser I. compared with ·1 microfarad; resistance with I., 493,560 ohms; resistance with ·1 microfarad, 105,800 + a variable resistance given below.

In the table in which the effect of the galvanometer is shown by the letters R, L, in the last column, R means there was a deflection to the right, L to the left.

Interval between galvanometer and battery contact.	Variable resistance to be added above.	Effect on galvanometer.
5"	$\left\{ \begin{array}{l} 700 \\ 400 \\ 500 \end{array} \right.$	R L very small R
2"	$\left\{ \begin{array}{l} 400 \\ 700 \\ 600 \end{array} \right.$	L R L
0"	$\left\{ \begin{array}{l} 1200 \\ 1300 \\ 1400 \end{array} \right.$	L Tremor L, then swing to R R

Thus in this case the effect of an alteration of 100 in the resistance, i.e.,  $\frac{1}{1000}$  of the whole, is very marked, and we may take the following values for R:—

5" interval	...	105,800 + 500
2" "	...	105,800 + 650
0" "	...	105,800 + 1300

Other series of observations showed that the resistance for 10 seconds interval was the same as for 5 seconds; if the interval was prolonged to 30 seconds a very small increase in capacity was noticeable. Thus the effect of absorption is to increase the capacity of the ·1 microfarad by about 8 in 1,000, or ·008 of the whole, of this ·0065 shows itself in the first 2 seconds of charging and ·0015 afterwards, the increase after 5 seconds, if any, being extremely small.

When comparing I. with ·5 microfarad the resistances used were 592,290 and 24,910 respectively. In this case an alteration in the latter resistance of 10 ohms, or  $\frac{1}{2300}$ , was easily seen. The following are the results:—

Interval.	Resistance.
10"	24,900
5"	24,900
2"	24,930
0"	25,060

Showing again that the absorption effect disappears after 5 seconds, and that the effect of absorption in 2 seconds is about ·0052, and in 5 seconds about ·0064 of the whole capacity.

When comparing with 1 microfarad, the resistances were 592,290 and 12,580, the last number being accurate to about 5 ohms, or about the same proportion as before.

The results of the various observations are given in the following table, the observations made with II. have been corrected for the leak as already explained.

TABLE giving the capacities of certain mica condensers as compared with the air condensers.

Date.	Value from I.	Value from II.	Value found by commutator at frequency 64.
Aug. 19	·04934	·04938	·04867
23	·04934	·04936	
June 17	·09772	·09780	·09638
Aug. 14	·09751		
18	·09773	·09786	
21	·09773	·09781	
Aug. 18 (M)	·5005	·5008	
18 (A)	·5007	·5009	
21	·5006	·5010	
Aug. 18	·9910	·9912	
21	·9913	·9912	

It will be noticed that, for either condenser I. or II., the results are in very close accordance; with the exception of one observation, on August 14th, the differences are barely as great as 1 in

5,000, and the method is clearly capable of giving the value of a mica condenser in terms of the air condenser, to this accuracy.

The reason for the low result on August 14th, is to be found in the fact that, on that day, the leak in I. was considerable, being, as we have seen, over 1 per cent. per minute. Full observations for the correction were not taken; it would, however, amount to about '0002, judged by the correction required to observations on II., when leaking at a similar rate.

The results from II. are equally consistent among themselves, but all slightly greater than those from I. This would indicate that the correction applied for the leak in II. is rather too large.

The capacities given in the table are those found with a five seconds interval, by which time, as we have seen, the absorption on the mica condensers used is practically complete. We have already discussed the method of determining the instantaneous capacity, and a table of the corresponding values could easily be given.

For our present purpose it is hardly necessary to do this and indeed for many purposes for which condensers are employed, a knowledge of the full capacity is more useful than one of the instantaneous one. In the last column the values of the capacities found by the commutator method are given the differences in both cases amount to about 1.3 per cent. of the capacity.

During the forthcoming year condenser II. will be again set up and tested and the permanent arrangements for rapidly comparing condensers and for issuing certificates will, I hope, be completed.

The discussion on this paper and the whole of the series will be given next week.

### LONDON COUNTY COUNCIL.

THE Autumn Session was commenced on Tuesday last, Sir JOHN LUBBOCK in the chair.

The report of the Highways Committee stated the council, on the 29th July last, authorised the committee to deal, during the vacation, with any matter within the scope of their reference, which might require immediate action on behalf of the council. Acting under this authority, they have considered the undermentioned notices under the Electric Lighting Orders and Acts, and have, subject to the conditions stated below in each case, sanctioned, on behalf of the council, the works referred to therein.

Notice, dated 25th July, 1890, from the Notting Hill Electric Lighting Company, of intention to lay mains on the west side of Aubrey Road, from Notting Hill Square to Aubrey House, was agreed to on condition that the company shall give three days' notice to the council's engineer before commencing the works.

Notice, dated 31st July, 1890, from the same company, of intention to lay mains in Victoria Gardens, Ladbroke Road, Horbury Crescent, and Kensington Park Road, in substitution for the works in those thoroughfares sanctioned by the council on 24th June last, on condition that the company shall give three days' notice to the council's engineer before commencing the work; that the cover stones of the culverts under 20 inches wide shall not be less than 2 inches thick, and of the wider culverts not less than 2½ inches; and that where the culverts cross the carriage way, there shall be at least 9 inches thickness of Portland cement concrete above the cover stones of the culvert, in addition to the road material.

Notice, dated 31st July, 1890, from the Westminster Electric Supply Corporation, of intention to lay mains in Eaton Square, Eaton Place, Chester Square, and Ebury Street. This notice is for an alteration of the route of the mains sanctioned by the council on 6th May last, the alteration being made to meet the wishes of the inhabitants of the locality. The company shall give three days' notice to the council's engineer before commencing the work: the mains shall be laid under the footways wherever it is found practicable to do so; and that the covers of the boxes to be used shall consist of iron frames, filled in with material to suit the paving.

Notice, dated 1st August, 1890, from the London Electric Supply Corporation, of intention to lay distributing mains in Great George Street, Princes Street and Victoria Street. That the company do give two days' notice to the council's engineer before commencing the work; that the mains shall be laid under the footway whenever it is found practicable to do so, and be kept at least 9 inches beneath the under side of the paving; and that where it is found necessary to lay the mains under the carriage-way, they shall be kept at least 9 inches below the concrete or the road material, as the case may be.

Notice, dated 31st July, 1890, from the St. James and Pall Mall Electric Light Company, under its order of 1890, of intention to lay mains in Burlington Gardens, Sackville Street, Swallow Street, Bury Street, St. James's Place, and part of Shaftesbury Avenue. On condition that a proper plan of the proposed works be supplied by the company before any of them are commenced; that the company do give two days' notice to the council's engineer before commencing the work in any street; that the mains in Shaftesbury Avenue be laid in the subway of that thoroughfare; that the positions to be occupied by the mains in the subway be subject to the approval of the engineer of the council, and that the work of placing them there be carried out to his satisfaction.

The committee also directed the clerk to give a formal notice to the company requiring it to lay the mains for Shaftesbury Avenue in the subway of that thoroughfare.

An application was also considered of the Westminster Electric Supply Corporation for sanction to the laying of a 9-inch wrought iron pipe (to be used as a water main) from Victoria Station to the company's premises in Eccleston Place, along Wilton Road, Buckingham Palace Road, Eccleston Street and Eccleston Place, as shown upon a plan submitted by the company, in addition to the electric mains in those thoroughfares sanctioned by the council on 1st April last. The laying of the pipe referred to was sanctioned on condition that it shall be laid at the same time as the mains already sanctioned for those thoroughfares.

The committee had to report that the electric testing station at Nos. 42 and 43, Cranbourne Street is approaching completion, and that they have arranged for Messrs. Hampton and Sons to supply the necessary furniture, fittings, blinds, &c., for the station, in accordance with an estimate submitted by that firm, for the sum of £169 9s. 9d. This expenditure was included in the estimate of £2,100 for apparatus and other necessary incidental expenses approved by the council on 3rd December last.

It was reported that Mr. J. Somers, who on 18th February last was appointed, at a salary of £2 a week to act as caretaker at the testing station, and to assist the inspector, has resigned his appointment. The committee have appointed a person, temporarily, to take charge of the premises until the end of the year; and will in due course submit to the council the name of a person for appointment as successor to Mr. Somers.

The council, on the 22nd of April last, authorised the continued employment in the engineer's department, until the first meeting after the recess, of a person, at a salary of £3 3s. a week, who has been since 25th February last assisting with the work connected with the business of which the committee has charge. The time referred to has now elapsed; but the engineer reports that the assistance is still necessary, in consequence of the large extent of the works being carried out in the public thoroughfares by the electric lighting companies, and of the extra work devolving upon the department in connection with the establishment of the electric testing station. The engineer also states that in order to cope with the work arising out of applications of tramway companies for sanction to the use of mechanical power, and also for the purpose of obtaining information and preparing a reliable plan of the existing tramways in London, in connection with the report on the subject prepared by the vice-chairman of the committee, he requires the assistance of a competent surveyor for a period of three months. They recommended "That the services of the temporary assistant now employed at a salary of £3 3s. a week in the engineer's department, be retained for a further period of three months, and that a competent surveyor be employed for the same period, at a salary not exceeding £4 4s. a week."

The committee have considered a notice, dated 18th August, 1890, from the Metropolitan Electric Supply Company, of intention to lay mains in Queen's Road and Gardens, Pickering Place and Terrace, Bishop's Road, Inverness Road, Place, and Terrace, Porchester Gardens, Terrace, and Place, Lower Porchester Street, Queensborough Terrace, James Street West, Gloucester Gardens, Square, Place, and Terrace, Leinster Street, Terrace, and Gardens, Craven Road, Hill, and Terrace, Craven Hill Gardens, Cleveland Square and Gardens, Westbourne Terrace, Crescent, and Street, Uxbridge Road, Upper Hyde Park Gardens and Street, Kensington Gardens Terrace, Sussex Terrace, Square, Place, and Gardens, Eastbourne Terrace, Spring Street, London Street, Stanley Street, Talbot Square and Street, Grand Junction Road, Cambridge Terrace, Street and Square, Norfolk Square and Crescent, Oxford Square and Terrace, Radnor Place, Sumer's Place, Southwick Crescent, Street, and Place, Upper Southwick Street, Hyde Park Street, Square, and Gardens, Albion Street, Connaught Square, Portsea Place, Edgware Road, Albion Place, Upper Berkeley Place, Upper Seymour Street West, Stanhope Street and Place, Lancaster Gate, Street, and Terrace, Star Street, Charles Street, Charles Street West, Bathurst Street, Chester Place, Clarendon Place, Clifton Place, Devonshire Terrace, and Devonport Street (2 plans). This notice is in respect of an extensive area, but the proposed works are of the same description as those of the same company which have been sanctioned by the council on previous notices; and recommended: "That the sanction of the council be given to the works referred to in the notice (Registered No. 103) of the Metropolitan Electric Supply Company, dated 18th August, 1890, upon condition that the company give two days' notice to the council's engineer before commencing the works in any of the thoroughfares specified in the notice; that the mains be enclosed in 5-inch iron pipe, and be laid under the footways wherever it is found practicable to do so; that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving; and that the works generally shall be of the description approved by the council on 1st October, 1889."

The following notices from the Notting Hill Electric Lighting Company were considered:—

August 20th, 1890, of intention to lay mains in Campden Hill Road; and to reduce the size of the culvert for the main in Campden Hill Gardens, already sanctioned by the council (1 plan).

23rd August, 1890, of intention to lay mains in Linden Gardens (1 plan).

5th September, 1890, of intention to lay pipes crossing High street, Notting Hill, Pembridge Gardens, Linden Grove and Dawson Place (1 plan).

22nd September, 1890, of intention to lay mains across Holland Park and Aubrey Road (1 plan).

24th September, 1890, of intention to lay a main on the east side of Pembroke Gardens (1 plan).

The proposed reduction in the size of the culvert in Campden Hill Gardens will be an advantage, inasmuch as the culvert will take up less space in the street; and the other works referred to in the notices are of the same character as those previously sanctioned by the council. The committee recommend: "That the sanction of the council be given to the works referred to in the notices (Registered Nos. 104, 105, 106, 107 and 108), dated 20th and 23rd August, and 5th, 22nd, and 24th September, 1890, respectively, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's engineer before commencing the work in any of the thoroughfares specified in the notices; that the cover stones of the culverts under 20 inches wide shall be not less than 2 inches thick, and of the wider culverts not less than 2½ inches; and that where the culverts cross the carriage-way, there shall be at least 9 inches thickness of Portland cement concrete above the cover-stones of the culvert, in addition to the road material."

The London Electric Supply Corporation has given a notice, dated 2nd September, 1890, of intention to lay trunk mains from Victoria Station (District Railway) across Buckingham Palace Road, and along Grosvenor Gardens to Ebury Street. The company has submitted a plan, which, in the opinion of the committee, is satisfactory, showing the manner in which the mains are to be protected from external injury; and there appears to be no objection to the proposed works, provided that the distributing mains for this route, for which notice has been given by the company (Registered No. 111), be laid, if possible, at the same time as the trunk mains. It was therefore recommended: "That the sanction of the council be given to the works referred to in the notice, dated 2nd September, 1890, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's engineer before commencing the works; that the mains be laid under the footways, and be kept two feet below the underside of the paving, wherever it is found practicable to do so; and that, if possible, the distributing mains for these thoroughfares be laid at the same time as the trunk mains."

The same company has also given the two notices under-mentioned:—

2nd September, 1890, of intention to lay distributing mains in Buckingham Palace Road, James Street, Little James Street, Buckingham Row, York Street, and Queen Anne's Gate.

3rd September, 1890, of intention to lay distributing mains in Knightsbridge Road, Wilton Place, Crescent and Road, Belgrave Square and Road, Upper and Lower Belgrave Streets, Hobart Place, Arabella Row, Grosvenor Place, Crescent and Gardens, Eaton Square and Place, Chesham Place, Lyall Street, Elizabeth Street, Chester Square, Eccleston Square and Street, Upper Eccleston Street, Ebury Street, Buckingham Palace Road, Eaton Lane North, St. George's Square and Warwick Square.

The committee, seeing no objection to the proposed works, recommend: "That the sanction of the council be given to the works referred to in the notices respectively, upon condition that the company do give two days' notice to the council's engineer before commencing the works in any of the thoroughfares specified in the notices; that the mains be laid under the footways, and be kept 9 inches below the underside of the pavement wherever it is found practicable to do so; and that where the mains cross carriage ways, they be kept at the same depth below the concrete or the road material, as the case may be."

The following notices of the Kensington and Knightsbridge Electric Lighting Company have also been considered:

3rd September, 1890, of intended extension in Montpelier Square, Rutland Gate, Cornwall Gardens, and Victoria Road (4 plans).

September 17th, 1890, of intended extensions in Young Street, and Exhibition Road (2 plans).

September 20th, 1890, of proposed extension in Queen's Gate Terrace (1 plan).

23rd September, of proposed extension in Cromwell Place (1 plan).

The works referred to in these notices are of the usual character, and it is recommended that the sanction of the council be given to the works referred to in the notices.

Notice dated September 4th, 1890, from the Chelsea Electricity Supply Company of intention to lay distributing mains in Bute Street, Sumner Place, Fulham Road, Alexander Square, Old Brompton Road, Onslow Square and Crescent, Pelham Street, Place, and Crescent, Thurloe Square, Alfred Place, East, South Street, Harrington Road, and road over Metropolitan Railway between Pelham Street and Thurloe Square (1 plan). The company states that the works will be carried out in the same manner as those previously approved by the council, but that it is not yet able to fix definitely the positions in which the various boxes are to be placed, received the sanction of the council on condition that a plan showing the positions to be occupied by the boxes, when decided upon, shall be submitted to the committee, and that the company do give two days' notice to the council's engineer before the works are commenced in any of the thoroughfares referred to in the notice.

The Westminster Electric Supply Corporation has given a notice, dated September 22nd, 1890, of intention to lay mains in Artillery Row, Old Rochester Row, Rochester Row, Great Peter Street, Vincent Square, and Churton Street. These works are such as have been approved by the council on former notices; but some of them will be in close proximity to the King's Scholar's Pond sewer, and the committee are of opinion that these should

be executed to the satisfaction of the council's engineer. The committee recommend: "That the sanction of the council be given to the works referred to in the notice on condition that the company do give two days' notice to the council's engineer before commencing the work; that the mains be laid under the footways wherever it is found practicable to do so; that the covers of the boxes to be used shall consist of iron frames, filled in with material to suit the paving; and that the works in the vicinity of the King's Scholar's Pond sewer be carried out to the satisfaction of the council's engineer."

The committee have considered a notice, dated August 27th, 1890, from Mr. H. Chadwick, on behalf of the Electricity Supply Corporation and Messrs. Gatti, of their intention to lay an electric cable along the Strand and Bedford Street. They were informed that the company has acquired, or is about to acquire, the right of lighting under the St. Martin's provisional order, 1889, and also the existing works of Messrs. Gatti, but that it is not clear that the necessary consents to such acquisition had yet been given. The committee have directed that further information be asked for; and pending the receipt of this, and having regard to the uncertainty as to the powers of the company, recommend: "That the council do give formal notice of disapproval of the works referred to in the notice (Registered No. 118), dated August 27th, 1890, of Mr. H. Chadwick, on behalf of the Electricity Supply Corporation and Messrs. Gatti."

The committee have, in accordance with the reference made to them by the council on 8th of July last, considered the following proposition by Mr. Leon: That inasmuch as many railway and other companies purpose making subways under "streets" in the County of London without paying compensation for such right of user, and whereas they will appropriate that property in the "streets" which is vested in the local authorities, and which may be required for the purpose of doing those things which commonly are done in or under the streets (such as subways and other works), the council resolves to recommend the local authorities not to consent to such user of the streets without compensation, and to petition Parliament against such Bills. That the Parliamentary Committee be instructed on all petitions of the council against Subway Railway Bills, to maintain the principle of compensation for such user, and assist as far as practicable any petitions presented by local authorities for that purpose. While agreeing with the principle of Mr. Leon's proposition, they were of opinion that it would be inexpedient for the council to pass any abstract resolution binding it to petition in a particular form in all cases, while the circumstances may be of infinite variety. When application is made to Parliament for compulsory powers to deal with the streets, the consent of the local authorities is not requisite if Parliament sees fit to grant the powers sought, but such bodies may, of course, oppose the granting of such powers. It was finally decided: "That it be an instruction to the Parliamentary Committee that, with reference to any railway or subway Bill for compulsory powers to carry out works under streets in the County of London, the committee do consider whether a petition should be presented against such Bill with a view to secure the insertion of proper provisions for payment of compensation to the public bodies in which such streets are vested, in respect of the beneficial user of the subsoil of such streets by the railway or other company or persons so using the same."

## REVIEWS.

*Screw Threads and Methods of producing them; with numerous Tables and complete directions for using Screw-Cutting Lathes.* By PAUL HASLACK. Third edition, rewritten and enlarged. London: Crosby, Lockwood & Son.

We are not surprised at the success which has attended this pocket-book, as it is extremely complete and concise. The work consists of seven chapters, dealing respectively with "Introductory Observations and Definitions," "Various Standard Screw Threads," "Plates, Die Stocks and Dies," "Screw-Cutting or Self-Acting Lathe," "Complex Rates and Hand Chasing," "Taps and Tap Making," "Tables of Screw Threads," &c. The importance of the subject of screw threads does not require enforcing, as it is almost self-evident; but how to practically deal with the question requires to be plainly set forth, as there are numerous points which have to be considered in order that the threads may be properly and easily formed. Examine under a magnifying glass the threads of screws cut by indifferently formed taps and dies, and the sight is not an attractive one, yet it is by no means difficult to so shape the taps and dies that the threads they cut are a pleasure to see. Anyone who carefully studies Mr. Hasluck's book shall have no difficulty in executing good work. As regards hardening and tempering, for example, we have the following precise instructions:—"Get plenty of water, such as a bucketful, add a hand-

ful of salt, and heat the taps one at a time in a clear fire till they are well red hot, but don't allow any of them to get hot enough to blister. When at the right heat stir round the water so as to make a small whirlpool in the bucket; take the tap and plunge it perpendicularly, threaded end first, quickly but steadily, into the centre of the whirlpool. If this is done carefully there will be little fear of the taps going out of shape, if they have been thoroughly annealed at least twice," &c.

*Journal of the Institution of Electrical Engineers.*  
No. 89, Vol. XIX. London: E. & F. N. Spon, 125, Strand.

The general contents of this number are as follows:—  
"On some chief features of the Edinburgh Exhibition, and mainly of the Electrical Section," by Prof. R. M. Walmsley; "Observations on Currents originating in ordinary Aerial Telegraph Conductors," by A. R. Bennett; "The Working Efficiency of Secondary Cells," by Prof. W. E. Ayrton; "On some Experiments in Radiometry," by A. R. Bennett; reply of Mr. K. L. Murray to the discussion on his paper "On the Lighting of the Centennial International Exhibition, Melbourne, 1888-89;" "A proposed system of Alarm Wires in Submarine Cables," by H. Kingsford.

*Water Purification for Manufacturers and Steam Users.* By SAWREY and COLLET.

This is a small book issued by the Stanhope Company, Limited, of patent telephone and water softener fame. The work is a very useful one, and of considerable value to those who have to deal with steam boilers, as the loss through scaling in the latter is often extremely heavy, being as much as 25 per cent. increase in the quantity of coal used when the scale is  $\frac{1}{8}$ th inch thick; this means about 22 pence extra per 1,000 gallons of water evaporated.

## ELECTRIC TRAMCAR SYNDICATE, LIMITED.

ON the afternoons of Tuesday and Thursday of this week, the Electric Tramcar Syndicate, Limited, who are working the Jarman patents, were enabled to run one of their new cars on the section of tram line between Clapham Common and Tooting. The London Tramways Company kindly gave the syndicate permission to use their line; but as the trips made by the electric car were sandwiched between those of the horse cars, apparently with a minimum of interruption to or interference with the ordinary traffic, and as each run was accomplished without a hitch or *contretemps* of any kind, we shall look forward to a time in the near future when these electrically-driven cars will take their regular place in the daily service between the above suburban districts. The road is well adapted for a tram line, being sufficiently wide for a double set of rails, with room on each side to allow carriages conveniently to pass. The gradients, for the most part, are not heavy, with the exception of a rise of 1 in 18 for a short distance, coming from Balham towards Clapham Common. The length of the line from the "Plough," High Street, Clapham, to the terminus at Tooting, is about two miles and a furlong.

In our issue of May 30th, 1890, we gave a full description of the car in an article entitled, "The Jarman System of Electric Traction." It will, therefore, suffice to briefly state that the car is of a similar pattern outwardly to the new two-horse tramcars, providing accommodation for 41 passengers, the outside being fitted with garden seats. The motor is double, the two armatures being carried on one spindle. The field magnets are wound on the "gamut" plan, to

facilitate the regulation of the motor and the consumption of power in proportion to the work to be done. The gearing consists of a single set of mortise wheels and pinions; the mortise wheels are of special construction, with vulcanised fibre teeth. The reduction in speed from the normal 650 revolutions per minute by the motor axle to 90 by the car wheels, provides for the propulsion of the car at the rate of between 7 and 8 miles per hour. This speed can be increased, when necessary, by using the full power of the motors in parallel to a maximum of about 16 miles per hour on the level. The motor and gearing are fixed to a steel frame attached to the axle boxes.

The driving arrangement is contained in a vertical case, enclosing a cylindrical commutator switch. By means of this switch all the manipulations requisite in working the car, whether for varying the speed, cutting off the current, or reversing the motor, are performed by turning one handle. Mr. Jarman has made a decided improvement by altering the position of the brake spindle, and placing it close alongside of the electrical switch; the brake handle is on a somewhat higher level than the driving one, to avoid the chance of any interference one with the other. The driver thus having both just under his hands should, certainly, derive some advantage in controlling the working of his car.

The battery of E.P.S. accumulators supplying the current to the motor consists of 52 double cells of the E type—19 plates in each cell—the whole coupled in series. The capacity of the cell is 140 ampère hours.

To enable the car to turn sharp curves, one of the wheels on the trailing axle is loose; this furnishes end play enough to allow the wheel base to accommodate itself to the different degrees of curvature to be found in the track usually laid down in this country.

The car which made the runs to Tooting was fitted with an ampèremeter and a Patterson and Cooper dead-beat magnet voltmeter, consequently we were able to take down a few readings to show the amount of electrical energy consumed during the journey. Of course, nothing more is shown than what may be termed the maxima and minima of consumption. The ground undulates, and some stretches on the road are worked by gravity alone; this applies in whichever direction the car is running.

The electric tramcar, with a full load of passengers, started from Clapham at 2.20 on Tuesday afternoon. The grade from thence is a gentle rise until the brow of the hill is reached above the down grade of 1 in 18; this steep declivity is of no great length, while the remainder of the distance to the fire station at Tooting is comparatively smooth, and only slightly variable. The journey was completed in 16 minutes; on the return, the time—including a wait to permit a horse-car to get a clear lead—was 19 minutes to Clapham. The second in and out journeys were accomplished in 18 and 16 minutes, respectively.

We append the actual time taken in running between certain landmarks on the road both going and returning. These figures exhibit what will prove to be the average time in which a distance of a little over 2 miles will be covered in everyday work where the general traffic may cause occasional delay.

### 1st Journey.

	h.	m.
Started from "Plough"	2	20
Cavendish Road	2	25
"George," Balham	2	27
Balham Station	2	33
Fire Station, Tooting	2	36

Total time, 16 min.

### Return.

	h.	m.
Leave Tooting	2	40
Balham Station	2	46
"George," Balham	2	54
Cavendish Road	2	56
"Plough," arrive	2	59

Total time, 19 min.

2nd Journey.

	h.	m.	
Started from "Plough"	3	3	
Cavendish Road ...	3	8	
"George," Balham ...	3	10	
Balham Station ...	3	15	
Fire Station, Tooting ...	3	21	
			Total time, 18 min.

The electrical power varied from 15 amperes at a pressure of 110 volts, to 50 amperes at 175 volts, with intervals when no current was required.

Return.

	h.	m.	
Leave Tooting. ...	3	38	
Balham Station ...	3	42	
"George," Balham ...	3	48	
Cavendish Road ...	3	50	
"Plough," arrive ...	3	54	
			Total time, 16 min.

The power consumed varied from 10 amperes at 120 volts, to 25 at 190. The gradient of 1 in 18 was negotiated at a slow speed with 50 amperes at a pressure of 90 volts; the run across Clapham Common being down hill, gravity did most of the work.

We understand that the officials of the Board of Trade are well satisfied with the working of the car, and the Jarman system generally. We also hear that the Electric Tramcar Syndicate has been requested by an influential firm in Spain to give it the option of introducing the system into that country.

NOTES.

**The Electric Light at Folkestone.**—After all the time and labour which the Folkestone Town Council have spent upon the question of lighting the town by electricity, the contract between them and Messrs. Crompton and Co. has been completely upset. It was stated at the last meeting of the corporation that the negotiations with Messrs. Crompton had cost something like £200, and it was strongly urged that the corporation should bring an action against the contractors to recover the money. The mayor was asked by Councillor Thompson to call a special meeting of the Electric Lighting Committee together in order that they might consider the advisability of taking proceedings, and the mayor promised to call it together at an early date. There can be no doubt that Messrs. Crompton & Co. will be very willing to contest the matter in a court of law; for after the treatment they received from the Folkestone corporation, they must be armed with every reason for their reluctance in carrying out their contract.

**The Electric Light at Exeter.**—At a meeting of the Town Council of Exeter, the special committee on Electric Lighting reported that they had received a letter from Mr. C. T. K. Roberts (solicitor to the Exeter Electric Light Company) enclosing two copies of the draft of the provisional order which the company intended applying for in the ensuing session. The draft was stated to be based on model order issued by the Board of Trade, and contained the latest modifications of such order. The committee, after considering the draft, were of opinion that the council should, in the interests of the citizens, itself apply for a provisional order to be confirmed by Parliament in the ensuing session for the supply of electricity within the city, and that the consent of the council should not be given to such an order being given to the Exeter Electric Light Company. After objection had been taken that the procedure suggested might involve an expenditure on the part of the council of possibly £30,000, it was decided to hold a special meeting to consider the matter.

**The Electric Light in Godalming.**—The Electric Lighting Commission, after visiting Bath, have reported favourably on the employment of electric light. It is intended to canvass the town to see if the majority of the inhabitants will support a scheme.

**Castleford and Street Lighting.**—The Local Board is asking for estimates for the lighting of the streets by electricity.

**Ship Lighting.**—The "Royal Steamship Packet Company" have just added to their fleet three or four large steamers, well equipped with electric lighting plant. The *Clyde*, the largest of the four, has an installation fitted by Siemens Brothers. The ship is wired on the single wire system, the ship giving the return. The dynamo is placed in the engine-room, and is driven by one of Tangye's vertical engines, coupled direct. At 200 revolutions the dynamos give an electromotive force of 115 volts with 220 amperes, and is sufficient to run 354 lights of 16 candle-power. There is a spare armature provided in case of breakdown. There are six main circuits, and throughout the ship are placed 36 ten-light distributing boxes. The principal advantage of the arrangement is that there are no joints in the system. From the one switch in the box the lights are controlled, and it is an easy matter to ascertain the position of any defect. Some of the lights are arranged to run independently of the switch, providing a night or police circuit. The rooms are all fitted with Edison-Swan lamps with frosted globes, and there are several cargo lamps of 4, 6, and 8 lights.

The ss. *Aranmore*, built for the Clyde Shipping Company, and intended for the South of England and South of Ireland trade, ran her trial trip on the Clyde on Saturday. The *Aranmore* has a complete installation of electric light in every part.

**Something Wrong.**—The *Standard*, on Tuesday, had a notice to the following effect:—"Owing to the interruption of telegraphic communication, we are this morning without a portion of our despatches from the Continent." Can it be that the Ferranti mains had anything to do with this interruption in the telegraphic service?

**Magdalen Islands Cables.**—We learn from the *Canadian Gazette* that the cable laid in 1880 between Cape Breton and Bird Rock, Gulf of St. Lawrence, is to be taken up and relaid to St. Paul's Islands. It is a coincidence that at the moment the cable is to be removed the daily journals should be discussing the sale of the Magdalen Islands to certain French capitalists.

**The Anticosti Cable.**—The Anticosti cable, just laid by Mr. Gisborne, commences at Mechestic Bay, Anticosti, and terminates at Tongue Pointe, on the north shore. The land lines to connect the cable with the existing telegraph system are being pushed forward, and, when completed, Anticosti will have cable communication with both shores of the gulf, and a land line round the south shore of the island, which has the reputation of being the graveyard of vessels. The cable referred to is 21 nautical miles in length, and was manufactured by the Silvertown Company. The laying was effected by the Government telegraph steamer *Newfield*.

**The Bahamas.**—In view of the success attending the more recent development of the fibre industry in the Bahamas, endeavours are being made to establish direct steam communication between Halifax and Nassau, and to subsidise steamers making the latter a port of call on the West Indian route. Steps are also being taken with the view of affording telegraphic facilities to the Bahamas by means of a cable between Nassau and Florida.

**Motors in Germany.**—The use of electro-motors in Germany is extending. Messrs. Ludwig, Löwe & Co., of Berlin, obtain current from the town electric light company's mains for driving the tools and machines in their workshops. The large steel works of Henkel, in Solingen, have an installation in which Lahmeyer dynamos and motors are employed. The whole of the works is lighted electrically, and the motors actuate 40 steel presses, lathes, and drilling machines. It is proposed to operate all the machinery by motors.

**Base-Ball Reporting.**—Reporters of cricket, football, tennis, &c., matches, must look to their electrical education, or the sporting journals they represent will be out of the hunt when compared with the enterprise and linguistic attainments shown by contributors to the technical Press. We select, as an example, a description of a base-ball match as reported in the columns of the *New York Electrical Engineer*:—"An exciting contest took place at Jackson Park, on Saturday last, between the Okonites and Kerites teams, composed, respectively, of the *employés* of the Central Electric Company and the Western Electric Company. The score was 21 to 6 in favour of the Kerites, and throughout the game their megohm capacity was never lowered in the slightest. The victors claim that their success was entirely due to the high insulation resistance they maintained. They short-circuited the bases in remarkable style, and no faults appeared, even under the high pressure current of the Okonites. The Okonites made a gallant struggle, but were unsuccessful in their endeavours to ground their opponents. The specific inductive capacity of both sides for hits of high voltage was enormous, and some fine work was witnessed by the numerous spectators, who said they had never seen a game so free from unnecessary retardation."

**The Advance in Rubber.**—The Gutta-Percha and Rubber Manufacturing Association of New York, at a meeting lately held, confirmed the advance of 10 per cent. on rubber goods made at the previous meeting. Prices of crude rubber had advanced 5 per cent., and some kinds were very scarce. The output from Brazil was as large this year as formerly, but the demand, both in the States and Europe, had increased enormously. It was announced that there would not be any further rise in the price of manufactured rubber for at least a month.

**Remedy for Vibration.**—It is said that felt made from hair, placed in the foundations of engines, effectively remedies the noise and vibration so often a cause of complaint. An electric company recently removed one of its 90 H.P. engines from its foundations, which were taken up to the depth of 4 feet. A layer of hair-felt, to the thickness of 5 inches, was then laid down, and run up round the sides to the height of 2 feet. The brickwork was then built up on the top of this.

**New Insulating Materials.**—Messrs. Alexander, Barney and Chapin, of New York, have introduced a new insulating material called "alexite." It can be made into any shape, and has the qualities necessary for cut-outs, switches, &c., being water, fire, and acid proof. Any colour of wood, paper, or marble can be closely imitated, so that, for interior wiring, harmony with the general upholstery can be maintained.

We have noticed in American technical journals very favourable reports as to the qualities of "fibrone" as an insulating material. It is a solid and plastic substance, said to present many of the most desirable characteristics of rubber. It is stated to be a perfect non-conductor, to be absolutely waterproof, and able to resist the weaker acids. It can be sawn, planed, drilled, tapped, or turned in a lathe, can be given delicate and bright colours, and can be made to represent natural woods, marble, stone, and metals. Under ordinary temperatures it does not expand or contract, blister, flake, or crack, and it is asserted that it can be made absolutely fire-proof. It is said that its cost is exceedingly low.

**Church Service by Telephone.**—As mentioned in our last issue, Christ Church, Birmingham, was to be connected by telephone. The experiment proved to be a distinct success, the service being well heard in London, Manchester, Derby, and other places. A local paper says when the morning service began there was what appeared to be an unseemly clamour to hear the service, and the opening prayer was interrupted on the wires by irreverent cries of "Hallo there." "Are you there." "No, I don't want the church."

**Laying a Telephone Cable.**—The *New York Electrical Engineer* of September 17th, contains an article on the laying of a telephone cable across the Hudson River. It appears that the Western Union Telegraph Company maintains an especially equipped cable steamer for the purpose of laying and repairing the numerous cables crossing the North River. This boat is called the *Western Union*, has much the appearance of a river tug, and is about 50 feet in length by 14 feet beam, and is provided with twin propellers. She has been in commission from January last, and was built to replace the old *Orton*, a vessel which had a long career of usefulness. On the main deck forward of the pilot house is the cable drum, set vertically, the lower side bearing on a number of small rollers fixed to the deck. Round the edge of the lower side of the drum is a brake strap to regulate the speed. The wheel for operating the brake, and a sliding rod by which the valve of the drum engine is opened or closed are placed on the bridge forward of the pilot house. A small iron pulley is attached to the end of a boom which can be swung out so that the pulley hangs clear of the vessel's side by about 8 or 10 feet. This pulley serves as a paying out or picking up sheave. A small steam winch forward of the drum completes the outfit. This arrangement would appear to serve very well for paying out, but for picking up we should imagine it to be a rather awkward method. The cable referred to was made for the Metropolitan Telephone Company, it contains 18 conductors and is of the Kerite type; the length laid was about one mile, and the weight nearly 20 tons.

**Creeping on Cells.**—M. Girard has suggested a simple process for preventing the creeping of salts, which weakens and destroys a cell. The idea is to apply with a brush a light coating of vaseline over the surfaces which require protection. Vaseline is unchangeable in air, is easily applied, and resists the action of a great number of chemical agents. An objection, we think, to the employment of this material lies in its stickiness—dust and all kinds of dirt being liable to adhere. A very ready method is the employment of melted wax; it has the advantage of presenting a smooth and hard surface.

**Telephony in Italy.**—Acting Consul F. T. Turner, of Naples, states that the number of subscribers to the telephone in that locality has not changed during the past two years, new subscribers having taken the place of those retiring. He believes it probable that the public are waiting before joining, in the expectancy that the Government will acquire the telephone service.

**Electric Bath Chair.**—The Vaughan-Sherrin Electrical Engineering Company, to which reference is made in another column, gave another demonstration this week at their works of the applicability of primary battery power to the propulsion of Bath chairs. A strong chair, weighing about 2 cwt., fitted with a battery at the back of the seat, went through some adjacent streets at a rate of about 5 miles an hour, and passed over a canal bridge with very little reduction of speed. As it is calculated that the cost of maintenance of the battery does not exceed 2d. per hour, and as no renewal would be required during an ordinary day's use, the application of electric propulsion to the Bath chair may prove both an improvement and an economy, if the claims put forward can be sustained.

**Treating Sewage by Electricity.**—In answer to the questions of a correspondent, we beg to refer him to the number of the *ELECTRICAL REVIEW* for October 11th, 1889.

**Electric Bells for Jamaica.**—Messrs. Cox & Co. have just completed a large installation of electric bells for the Constant Spring Hotel, Jamaica, including two of their improved electric reversing annunciators of 75 numbers each.

**Gutta-percha.**—At the meeting of the Paris Academy of Sciences, on September 15th, M. Serullas read a paper on the *Isonandra Gutta*. The author gives an account of this plant, both as to its discovery and as to the growth of certain varieties. Some interesting information with regard to the employment of gutta-percha for industrial and commercial purposes is also given.

**Personal.**—Mr. A. Grundy has retired from the firm of Baily and Grundy, of Paddington and Cambridge, and joined the staff of the Gülcher Electric Light and Power Company, Limited.

**Newcastle-upon-Tyne Electric Supply Company.**—The offices of this company are removed to the works at Pandon Dene, Newcastle.

**Telephonic.**—An important test of the capabilities of the Berthon telephone to work on telegraph wires is about to be made on the railway telegraph wires between Perth and Inverness.

**Electric Tramway.**—Bailies Paton and M'Farlane, of Glasgow, accompanied by Mr. Rankine, engineer, are in Birmingham gathering information about the electric tramways.

**Woodhouse and Rawson v. Appleton, Burbey, and Williamson.**—This cricket match was played at Brentwood, Essex, on Saturday last, and, after an enjoyable game, ended in an easy win for the former by nearly 300 runs.

**A Telegraph Superintendent Killed.**—William York, an *employé* of the Midland Railway, in charge of the telegraph extensions, met with a fearful death last week at Thwaites, a village near Bradford. He was engaged supervising the workmen under his control, and, not noticing the advance of the 10.30 express from Leeds, stepped on the line in front of it. His body was cut into two pieces in the sight of his workmen.

**New Electrical Journal.**—To-morrow there is to be started a penny weekly paper, entitled, *Electricity*. The editor is Dr. Julius Maier, and the publishers Messrs. Swan, Sonnenchein & Co.

**Seasonable Caution.**—*Electrical Plant* wonders when young and aspiring electricians, at the beginning or early period of their experience as masters, will learn that the manufacture of dynamos is *not* the certain road to fortune. Reckoning up the present number of dynamo manufacturers, our contemporary concludes that the capacity for supply greatly exceeds the demand, and advises young electricians to eschew any attempts to add to the number already in the market.

**"Martin" Wires.**—The Telegraph Administrations of Greece, Sweden and Switzerland have, following the lead of France, adopted the bi-metallic "Martin" wires for their telegraph and telephone systems.

**Electricity in Australia.**—The Australian papers by the last mail say that it is intended to place the electric light in the New South Wales Parliament. Previously gas has been used, but numerous has been the complaints against the heat, so it is resolved to adopt electricity. An interesting exhibition was given in the central station of the electric light company in Melbourne some nights ago. At the invitation of the engineer, prominent citizens had gathered to witness, as far as Australia is concerned, a new departure made by electricity. It was nothing more than making a cook-shop of the station. By a method which was not communicated, beef steaks were well cooked, toast was made, water boiled, and most of the culinary arts received attention.

**Buller, Jobson & Co., Limited.**—This company has acquired a site for extensive new works at Cheston Road, Birmingham. The company is to be reconstructed with extended powers and the capital has been increased. The proprietary remains the same, but the name is to be changed to Bullers, Limited.

**The Madrid School of Mines.**—It has been determined by the Official Inspectors of the Madrid School of Mines to devote a class for the instruction of pupils in electricity as applied to mining and metallurgy. There seems, however, to be some difficulty as to the appointment of a thoroughly qualified professor in this particular branch of electro-technics.

**Reduction in the Price of Tubes and Fittings.**—Joseph Aird, Tube Works, Great Bridge, Staffordshire, and 46, Queen Victoria Street, E.C., gives notice that he has increased his discounts 5 per cent. gross upon gas, steam, galvanised, and water tubes and fittings.

#### NEW COMPANIES REGISTERED.

**Elmore's Austro-Hungarian Patent Copper Depositing Company, Limited.**—Capital £200,000, in £2 shares. Objects: To carry out an agreement entered into with the Elmore Foreign and Colonial Depositing Company, Limited, and Woodhouse and Rawson United, Limited. To carry on in Austria, Hungary, and elsewhere the business of manufacturers of and dealers in copper and other metals, and all metallic alloys or compounds of the same. To supply electricity in all branches, and to carry on the business of electricians, electrical contractors, electrical and mechanical engineers. Signatories (with 1 share each): G. Worrall, 29, Percy Road, Forest Gate; J. Mumford, 50, Trinity Square, Borough; A. M. G. Carter, 40, Danning Road, Hampstead; B. F. Howard, Beckenham; H. Villars, 6, Penshurst Road, N.E.; A. W. Taylor, 53, Bloemfontein Avenue, Shepherd's Bush; and E. W. Clayton, Southfields, S.W. The signatories appoint the first directors, any shareholder being eligible; remuneration £200 per annum each, with an additional £200 for the chairman and £100 for the vice-chairman, also 2½ per cent. commission upon the net profits made from manufacturing and upon the revenue accruing from licensing or sub-licensing the company's patents; and 1 per cent. upon the net profits made from sales of patents, licenses, or businesses. Registered 26th ult. by Ashurst, Morris and Co., 6, Old Jewry, E.C.

**Unsworth and Richmond, Limited.**—Capital £20,000, in £10 shares. Objects: To take over the business of manufacturer of gas cooking and heating appliances carried on by Wm. Unsworth at Warrington. To carry on business as gas, electrical, and general engineers. Signatories (with 1 share each): \*Wm. Mortimer, \*Wm. Unsworth, \*L. Voisey, W. D. Jeans, all of Warrington; E. Richmond, Leicester; Wm. Atkins, Matlock; \*E. W. T. Richmond, Southport. The signatories denoted by an asterisk are the first directors; qualification, 50 shares; the company in general meeting will appoint remuneration. Registered 26th ult. by Field, Roscoe & Co., 36, Lincoln's Inn Fields.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Buenos Ayres Electric Light Company, Limited.**—The annual return of this company, made up to the 14th June, 1889, was filed on the 20th ult. The nominal capital is £100,000, divided into 9,986 shares of £10 each and 70 founders' shares of £2 each. At the date of the return the founders' shares had been allotted, but no call had been made in respect thereof.

The return for the present year is made up to the 14th June, 1890, and was filed on 20th September. The only shares recorded as taken up are the 70 founders'

shares, upon which no amount has been called or paid, so that the company continues without an actual paid up capital.

**MacMahon's Electric Automatic Registering Company, Limited.**—At a meeting of this company, held on the 18th of August, an account was given as to the way in which the winding up of the company has been conducted, and its property disposed of. The notification of such meeting was filed on the 23rd ult.

**Exeter Electric Light Company, Limited.**—An agreement of 9th September, filed 27th September, between this company and the Brush Electrical Engineering Company, Limited, cites, that the latter company had agreed to sell and deliver to the Exeter Company, certain machinery and articles, and would accept payment of one-third of the price by an allotment of shares to the amount of one-third of the price. in the ordinary share capital of this company. Machinery and articles to the value of £2,160 have been supplied, and, in accordance with such arrangement, 72 fully paid shares of £10 each will form part of the purchase consideration.

**Provincial Electric Light and Power Supply Limited.**—The registered office of this company is at Westminster Chambers, 5, Victoria Street, Westminster.

**Stamford Hill, Tottenham and Edmonton Electric Light and Power Supply, Limited.**—The registered office of this company is at Westminster Chambers, 5, Victoria Street, S.W.

**Camberwell and Islington Electric Light and Power Supply, Limited.**—The registered office of this company is situate at Westminster Chambers, 5, Victoria Street, S.W.

**Devonshire Electric Light and Power Supply, Limited.**—The registered office of this company is situate at Westminster Chambers, 5, Victoria Street, S.W.

**Barry and Cardiff Electric Light and Power Supply, Limited.**—The registered office of this company is situate at Westminster Chambers, 5, Victoria Street, Westminster.

**East Coast Electric Light and Power Supply, Limited.**—The registered office is at Westminster Chambers, 5, Victoria Street, Westminster.

**Kidderminster Electric Light and Power Supply, Limited.**—The registered office is situate at Westminster Chambers, 5, Victoria Street, Westminster.

**Maxim-Weston Electric Company, Limited (in Liquidation).**—The registered office of this company is now situate at the Works, Boleyn Road, Kingsland Green, N.E.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Direct Spanish Telegraph Company, Limited.

SIR JAMES ANDERSON presided at the half-yearly meeting of shareholders held at Winchester House on Tuesday last, and, in presenting the directors' report (printed in our last issue), and accounts for the half year, said: The shareholders would remember that at the last meeting he spoke of the approaching Telegraphic Conference as having some new terrors for the company, especially as regards its tariff of 4½d. a word. The odd half-penny had in fact been taken away, and but for the good offices of the Post Office delegate, and the Spanish delegates, the company might have fared even worse. It seemed a small matter to cry over, but that half-penny with other small adjustments, represented a sum of £3,500 a year. It required some confidence in order to feel sanguine that it would be recouped by an increase of traffic, still he thought that to a large extent it would be recouped. During the last three years the company's traffic had been steadily increasing; the commercial interests of Spain seemed to have taken a very promising start in the company's interests. He spoke last year of the use of code language and the effect it had in reducing the tariffs of cable companies. Codes were so scientifically arranged that whole circulars could be telegraphed in one or two words. He believed he spoke within bounds when he said

that the average of every word of code language was nearly ten ordinary words. Indeed, he had known some to express 24 and 25 words of plain language. That seemed at one time to threaten a reduction in the company's revenue, and in the length of messages at the rate of one word per message per annum. This year, however, he was happy to tell them there had been a slight increase in the length of messages. He was sorry to say that the company's managers would not let him attribute it to causes connected with the ordinary conditions of commerce. They attributed it to other causes which he would not dwell upon. For the last two years the company's earnings had been at about the same level, and if the traffic continued to increase, and code language remained unchanged, it would get along fairly well. Last year the company made a round £1,500 more money and carried one hundred and sixty thousand more words at a cost of £300 odd. This year it had carried two hundred thousand and odd words more, and had increased its revenue by £2,000 odd at a smaller outlay of £300 odd. Apparently it was on the right track. All its cables were in good order. On the other hand, they had to face the necessity for duplexing their cable at a cost of nearly £800. For that and some other reasons he advised them not to make use of the money. With a 6 per cent. dividend and an increase in the commercial revenue, he thought the directors would not act prudently if they failed to keep before them the fact that the company had a debenture debt of £62,000, carrying interest at 6 per cent. It was not a sound position to be in, and therefore they ought to allow their directors to devote any surplus to wiping off this debenture debt and duplexing their cable. They could then look forward to 1894, when the debentures fell due; and they might possibly be in a position to lay down an additional cable if the traffic continued to increase. The £20,000 they had in reserve would not go very far towards the cost of a new cable. The directors were very anxious to have a sum in hand for contingencies without trenching upon the reserve fund. If in 1894 these conditions—a sound property and an increasing traffic, with a 6 per cent. dividend—continued, he anticipated no difficulty in finding money amongst themselves to pay off their debenture debt. By that time their reserve would be £40,000 or with the cash in hand £50,000; and they would be able to say with confidence that the Direct Spanish was one of the soundest telegraph investments in London.

Mr. Etlinger seconded the motion which was carried unanimously.

The Chairman also moved, seconded by Mr. Etlinger, the declaration of a dividend of 10 per cent. per annum, less income tax on the preference shares, and of 6 per cent. per annum on the ordinary shares, free of income tax, both for the half-year ending 30th June, 1890. The motion was carried unanimously.

An extraordinary meeting was then held and the following special resolution was unanimously passed:—"That Article 71 of the Articles of Association of the company be and is hereby repealed and instead thereof the following be a regulation of the company."

"The directors shall receive as remuneration for their trouble in the execution of their office the sum of £600 per annum, or such other sum as the company in general meeting may from time to time determine, and such remuneration shall be apportioned by the directors among themselves in such manner as they shall from time to time think fit."

The proceedings then closed with a vote of thanks to the Chairman and directors.

**Elmore's Austro-Hungarian Patent Copper Depositing Company, Limited.**—The capital is £200,000, of which 75,000 shares of £2 each are now offered for subscription at a premium of 10s. per share, and 25,000 are accepted in part payment of the purchase money. This company has been formed to acquire the patents for the Empire of Austria-Hungary relating to the discovery made by Messrs. Francis Edward Elmore and Alexander Stanley Elmore, for manufacturing copper articles direct from rough copper bars, with right to the Messrs. Elmore to use the said patents for certain special applications. The invention, it is claimed, does away with the processes of melting, rolling, forging, drawing &c., and the present costly and laborious methods of manufacturing.

**Anglo-American Telegraph Company, Limited.**—The directors declare an interim dividend for the quarter ending 30th September, 1890, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income tax, payable on the 1st November, to the stockholders registered on the books of the company on the 30th September, 1890.

**Eastern Telegraph Company, Limited.**—The directors announce the usual 2s. 6d. interim dividend.

**Submarine Cables Trust.**—The payment on the 15th inst. of the coupons due in April last is notified.

### TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending September 26th, were £4,970.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 26th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,899.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (September 25.)	Closing Quotation. (October 2.)	Business done during week ending October 2, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	98 — 101	101	100½
1,549,160	Anglo-American Telegraph, Limited	Stock	51 — 52	51 — 52	51	...
2,725,420	Do. do. 6 p. c. Preferred ...	Stock	87½ — 88½	87½ — 88½	88½	87½
2,725,420	Do. do. Deferred ...	Stock	14½ — 15½	14½ — 15½	14½	14½
130,000	Brazilian Submarine Telegraph, Limited ...	10	11½ — 12½	11½ — 12½	12	11½
99,000	Do. do. 5 p. c. Bonds...	100	100 — 102	100 — 102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416...	3	1½ — 2	1½ — 2		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 1½	1½ — 2		
\$7,216,000	Commercial Cable, Capital Stock ...	\$100	103 — 105	102 — 104 xd	103½	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	9 — 10	9 — 10		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,000	Cuba Telegraph, Limited ...	10	12 — 12½	11½ — 12½	11½	...
6,000	Do. do. 10 p. c. Preference ...	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited ... (£4 only paid)	5	4 — 4½	4 — 4½		
6,090	Do. do. 10 p. c. Preference ...	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10 — 9/16	10½
400,900	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14½	14 — 14½	14½	14
70,000	Do. 6 p. c. Preference ...	10	15 — 15½	15 — 15½		
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109		
1,200,000	Do. 4 p. c. Mortgage Debenture Stock ...	Stock	104 — 107	104 — 107		
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14½ — 14½	14½ — 14½	14½	14½
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102		
446,100	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. ...	100	103 — 106	101 — 104	102½	...
12,500	Do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	103 — 106	101 — 104		
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900...	100	102 — 105	101 — 104		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8½	7½ — 8½	7½	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	6 — 6½	5 — 5½	6½	5½
67,385	(Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid)	2	1 — 1½	2½ — 2½	1 7/16	...
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 ... (£3 only paid)	5	2½ — 3	3½ — 4		
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	8½ — 9½	9 1/10	8 1/10
180,042	Do. do. 6 p. c. Preference ...	10	14½ — 15	14½ — 15	14½	...
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	16½	15½
40,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	100 — 103	100 — 103	101	...
250,000	Do. do. (issue of 1883)	100	104 — 107	104 — 107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½		
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 — 19	18½ — 19½	19	18½
200,000	Do. do. 4½ p. c. Deb., 1896...	100	102 — 104	100 — 102 xd		
17,000	Indo-European Telegraph, Limited...	25	36 — 38	36 — 38	37	36½
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6½ — 7½		
100,000	Do. do. 6 p. c. Debentures	100	105 — 108	105 — 108		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4 — 4½	4 — 4½		
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4½ — 4½	4½ — 4½	4 1/16	4½
15,000	Do. 6 p. c. Cum. 1st Preference ...	10	12 — 12½	12½ — 12½	12 5/16	...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	1 — 1½	1 — 1½		
9,000	Reuter's, Limited	8	8 — 8½	8½ — 8½		
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	1 — ...	1 — ...		
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3		
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117		
78,949	Swan United Electric Light, Limited ... (£3½ only paid)	5	5½ — 5½	5½ — 5½	5½	...
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	44½	43½
150,000	Do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
55,000	United River Plate Telephone, Limited	5	3½ — 4	3½ — 4		
146,000	Do. do. 5 p. c. Debenture Stock...	Stock	90 — 94	90 — 94		
100,000	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9 — 10	9 — 10		
300,000	Do. do. 5 p. c. Debentures	100	99 — 102	99 — 102	99½	99
30,000	West Coast of America Telegraph, Limited	10	4½ — 5	4½ — 5	4½	4½
150,000	Do. do. 8 p. c. Debs, repay. 1902	100	103 — 108	102 — 107	104½	102½
64,572	Western and Brazilian Telegraph, Limited	15	11 — 11½	11½ — 11½	11½	11½
26,986	Do. do. 5 p. c. Cum. Preferred ...	7½	6½ — 7	6½ — 7½	7 1/16	7
26,986	Do. do. 5 p. c. Deferred ...	7½	4½ — 5½	4½ — 5½		
200,000	Do. do. 6 p. c. Debentures "A," 1910...	100	103 — 106	103 — 106		
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	101 — 104	103 — 106		
88,321	West India and Panama Telegraph, Limited	10	3½ — 3½	3 — 3½	3½	3
34,563	Do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 12	11 1/16	11½
4,669	Do. do. 6 p. c. 2nd Preference	10	14 — 15	14 — 15	14½	14½
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	122 — 127	122 — 127		
179,300	Do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1½ — 1½	1 — 1½	1 1/16	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 1 1/16—1 1/16.—House-to-House Company (£5 paid), 5—5½.—International Okonite, Ordinary of £10 (£7 paid), 6½—7½.—London Electric Supply Corporation, Ordinary (£5 paid) 2½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/-—13/-.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 376.)

(C) *Divided Bar Method.*—This method, due to Dr. Hopkinson,† is illustrated by fig. 17.  
The apparatus consists of a block of annealed wrought iron about 18 inches long, 6½ wide, 2 deep, out of the middle of which is cut out a rectangular space to receive the magnetising coils.

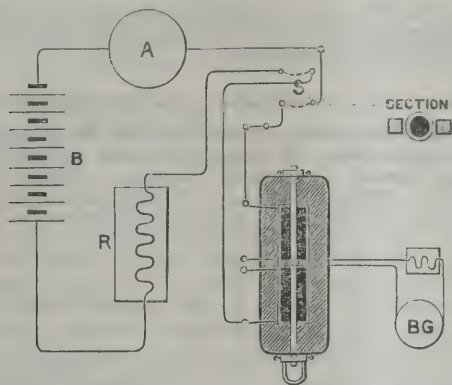


FIG. 17.—HOPKINSON'S DIVIDED BAR METHOD OF MEASURING MAGNETIC PERMEABILITY.

The test samples of iron consist of two rods, each 12·65 millimetres in diameter, turned carefully true, and slide in through holes bored in the ends of the iron blocks. These two rods meet in the middle, their ends being faced true so as to make a good contact. One of them is secured firmly, and the other has a handle fixed to it, by means of which it can be withdrawn. The two large magnetising coils do not meet, a space being left between them. Into this space is introduced the little exploring coil, wound upon an ivory bobbin, through the eye of which passes the end of the movable rod. The exploring coil is connected to the ballistic galvanometer, BG, and is attached to an India-rubber spring (not shown in the fig.), which, when the rod is suddenly pulled back, causes it to leap entirely out of the magnetic field. The exploring coil had 350 turns of fine wire; the two magnetising coils had 2,008 effective turns. The magnetising current, generated by a battery, B, of eight Grove cells, was regulated by a variable liquid resistance, R, and by a shunt resistance. A reversing switch and an amperemeter, A, were included in the magnetising circuit. By means of this apparatus the sample rods to be experimented upon could be submitted to any magnetising forces, small or large, and the actual magnetic condition could be examined at any time by breaking the circuit and simultaneously withdrawing the movable rod. This apparatus, therefore, permitted the observation separately of a series of increasing (or decreasing) magnetisations without any intermediate reversals of the entire current. Thirty-five samples of various irons of known chemical composition were examined by Hopkinson, the two most important [for present purposes] being an annealed wrought iron

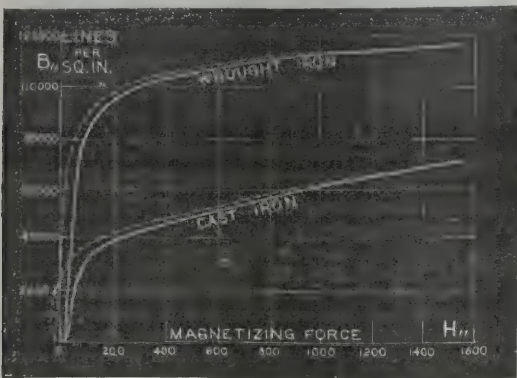


FIG. 18.—CURVES OF MAGNETISATION OF IRON.

and a grey cast iron, such as are used by Messrs. Mather and Platt in the construction of dynamo machines. Hopkinson embodied his results in curves, from which it is possible to construct, for purposes of reference, numerical tables of sufficient accuracy to serve for future calculations. The curves of these two samples of iron are reproduced in fig. 18, but with one simple modification.

\* Cantor Lecture. Delivered before the Society of Arts, January 20th, 1890.  
† "Phil. Trans.," 1885, p. 564.

British engineers who unfortunately are condemned by local circumstances to use inch measures instead of the international metric system, prefer to have the magnetic facts also stated in terms of square inch units instead of square centimetre units. This change has been made in fig. 18, and the symbols  $B_{in}$  and  $H_{in}$  are chosen to indicate the numbers of magnetic lines to the square inch in iron and in air respectively. The permeability, or multiplying power of the iron is the same, of course, in either measure. In Table II. are given the corresponding data in square inch measure; and in Table III. the data in square centimetre measure for the same specimens of iron.

TABLE II.—(Square inch units.)

Annealed wrought iron.			Grey cast iron.		
$B_{in}$	$\mu$	$H_{in}$	$B_{in}$	$\mu$	$H_{in}$
30,000	4650	6·5	25,000	763	32·7
40,000	3877	10·3	30,000	756	39·7
50,000	3031	16·5	40,000	258	155
60,000	2159	27·8	50,000	114	439
70,000	1921	36·4	60,000	74	807
80,000	1409	56·8	70,000	40	1189
90,000	907	99·2	—	—	—
100,000	408	245	—	—	—
110,000	166	664	—	—	—
120,000	76	1581	—	—	—
130,000	35	3714	—	—	—
140,000	27	5185	—	—	—

TABLE III.—(Square centimetre units.)

Annealed wrought iron.			Grey cast iron.		
B	$\mu$	H	B	$\mu$	H
5,000	3000	1·66	4,000	800	5
9,000	2250	4	5,000	590	10
10,000	2000	5	6,000	279	21·5
11,000	1692	6·5	7,000	133	42
12,000	1412	8·5	8,000	100	80
13,000	1083	12	9,000	71	127
14,000	823	17	10,000	53	188
15,000	526	28·5	11,000	37	292
16,000	320	50	—	—	—
17,000	161	105	—	—	—
18,000	90	200	—	—	—
19,000	54	350	—	—	—
20,000	30	666	—	—	—

It will be noted that Hopkinson's curves are double, there being one curve for the ascending magnetisations, and a separate one, a little above the former, for descending magnetisations. This is a point of a little importance in designing electro-magnets. Iron, and particularly hard sorts of iron, and steel, after having been subjected to a high degree of magnetising force, are subsequently to a lesser magnetising force found to retain a higher degree of magnetisation than if the lower magnetising force had been simply applied. For example, reference to fig. 18 shows that the wrought iron, where subjected to a magnetising force gradually rising from zero to  $H_{in} = 200$ , exhibits a magnetisation of  $B_{in} = 95,000$ ; but after  $H_{in}$  has been carried up to over 1,000, and then reduced again to 200,  $B_{in}$  does not come down again to 95,000, but only to 93,000. Any sample of iron which showed great retentive qualities, or in which the descending curve differs widely from the ascending curve, would be unsuitable for constructing electro-magnets, for it is important that there should be as little residual magnetism as possible in the cores. It will be noted that the curves for cast iron show more of this residual effect than do those for wrought iron. The numerical data in Tables II. and III. are means between the ascending and descending values.

As an example of the use of the tables, we may take the following:—How strong must the magnetising force be in order to produce in wrought iron a magnetisation of 110,000 lines to the square inch? Reference to Table II., or to fig. 18, shows that a magnetising field of 664 will be required, and that at this stage of the magnetisation the permeability of the iron is only 166. As there are 6·45 square centimetres to the square inch, 110,000 lines to the square inch correspond very nearly to 17,000 lines to the square centimetre; and  $H_{in} = 664$  corresponds very nearly to  $H = 100$ .

TRACTION METHODS.

Another group of methods of measuring permeability is based upon the law of magnetic traction. Of these there are several varieties.

(D) *Divided Ring Method.*—Mr. Shelford Bidwell has kindly lent me the apparatus with which he carried out this method. It consists of a ring of very soft charcoal iron rod 6·4 millimetres in thickness, the external diameter being 8 centimetres, sawn into two half rings, and then each half carefully wound over with an

exciting coil of insulated copper wire of 1,929 convolutions in total. The two halves fit neatly together; and in this position it constitutes practically a continuous ring. When an exciting current is passed round the coils both halves become magnetised and attract one another. The force required to pull them asunder is then measured. According to the law of traction, which will occupy us in the second lecture, the tractive force (over a given area of contact) is proportional to the square of the number of magnetic lines that pass from one surface to the other through the contact joint. Hence the force of traction may be used to determine  $B$ ; and on calculating  $H$  as before, we can determine the permeability. The following Table IV. gives a summary of Mr. Bidwell's results.

(E) *Divided Rod Method.*—In this method, also used by Mr. Bidwell, an iron rod hooked at both ends was divided across the middle, and placed within a vertical surrounding magnetising coil. One hook was hung up to an overhead support; to the lower hook was hung a scale-pan. Currents of gradually-increasing strength were sent around the magnetising coil from a battery of cells, and note was taken of the greatest weight which

TABLE IV.—(Square centimetre measure.)

Soft charcoal iron.		
B	$\mu$	H
7,390	1899.1	3.9
11,550	1121.4	10.3
15,460	386.4	40
17,330	150.7	115
18,470	88.8	208
19,330	45.3	427
19,820	33.9	585

could in each case be placed in the scale-pan without tearing asunder the ends of the rods.

(F) *Permeameter Method.*—This is a method which I have myself devised for the purpose of testing specimens of iron. It is essentially a workshop method, as distinguished from a laboratory method. It requires no ballistic galvanometer, and the iron does not need to be forged into a ring or wound with a coil. For

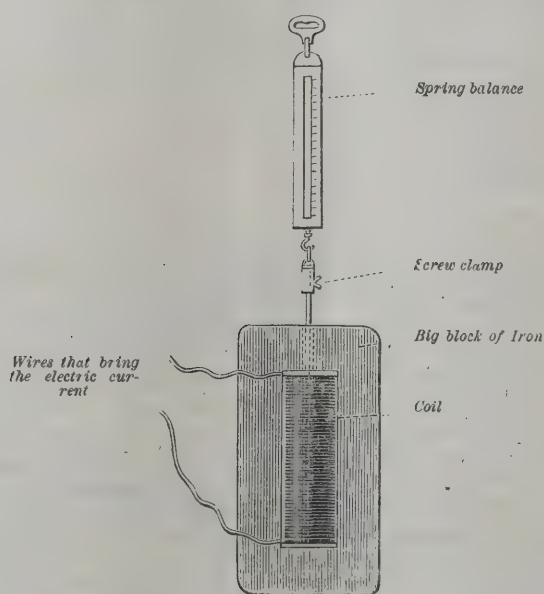


FIG. 19.—THE PERMEAMETER.

carrying it out a simple instrument is needed, which I venture to denominate as a *permeameter*. Outwardly, it has a general resemblance to Dr. Hopkinson's apparatus, and consists, as you see (fig. 19), of a rectangular piece of soft wrought-iron, slotted out to receive a magnetising coil, down the axis of which passes a brass tube. The block is 12 inches long, 6½ inches wide, and 3 inches in thickness. At one end the block is bored to receive the sample of iron that is to be tested. This consists simply of a thin rod about a foot long, one end of which must be carefully surfaced up. When it is placed inside the magnetising coil, and the exciting current is turned on, the rod sticks tightly at its lower end to the surface of the iron block; and the force required to detach it (or, rather, the square root of that force) is a measure of the permeation of the magnetic lines through its end-face. In the first permeameter which I constructed the magnetising coil is 13.64 centimetres in length, and has 271 turns of wire. One ampère of exciting current consequently produces a magnetising force of  $H = 34$ . The wire is thick enough to carry 30 amperes, so that it is easy to reach a magnetising force of 1,000. The current I now turn on is 25 amperes. The two rods here are of "charcoal iron"

and "best iron" respectively; they are of quarter-inch square stuff. Here is a spring balance graduated carefully and provided with an automatic catch so that its index stops at the highest reading. The tractive force of the charcoal iron is about 12½ lbs., while that of the "best" iron is only 7½ lbs.  $B$  is about 19,000 in the charcoal iron, and  $H$  being 850,  $\mu$  is about 22.3. The law of traction which I use in calculating  $B$  will occupy us much in the next lecture, but meantime I content myself in stating it here for use with the permeameter. The formula for calculating  $B$  when the core is thus detached by a pull of  $P$  pounds, the area of contact being a square inches, is as follows:—

$$B = 1,317 \times \sqrt{P \div A + H}.$$

I may add that the instrument, in its final form, is manufactured from my designs by Messrs Nalder Bros., the well-known makers of so many electrical instruments.

## CURVES OF MAGNETISATION AND PERMEABILITY.

In reviewing the results obtained, it will be noted that the curves of magnetisation all possess the same general features, all tending toward a practical maximum, which, however, is different for different materials. Joule expressed the opinion that "no force of current could give an attraction equal to 200 lbs. per square inch," the greatest he actually attained being only 175 lbs. per square inch. Rowland was of opinion that the limit was about 177 lbs. per square inch for an ordinary good quality of iron, even with infinitely great exciting power. This would correspond roughly to a limiting value of  $B$  of about 17,500 lines to the square centimetre. This value has, however, been often surpassed. Bidwell obtained 19,820, or possibly a trifle more, as in Bidwell's calculation the value of  $H$  has been needlessly discounted. Hopkinson gives 18,250 for wrought iron, and 19,840 for mild Withworth steel. Kapp gives 16,740 for wrought iron, 20,460 for charcoal iron in sheet, and 23,250 for charcoal iron in wire. Bosanquet found the highest value in the middle bit of a long bar to run up in one specimen to 21,428, in another to 29,388, in a third to 27,688. Ewing, working with extraordinary magnetic power, forced up the value of  $B$  in Lowmoor iron to 31,560 (when  $\mu$  came down to 3), and subsequently to 45,350. This last figure corresponds to a traction exceeding 1,000 lbs. to the square inch.

Cast iron falls far below these figures. Hopkinson, using a magnetising force of 240, found the values of  $B$  to be 10,783 in grey cast iron, 12,408 in malleable cast iron, and 10,546 in mottled cast iron. Ewing, with a magnetising force nearly fifty times as great, forced up the value of  $B$  in cast iron to 31,760. Mitis metal, which is a sort of cast wrought iron, being a wrought iron rendered fluid by addition of a small percentage of aluminium, is, as I have found, more magnetisable than cast iron, and not far inferior to wrought iron. It should form an excellent material for the cores of electro-magnets for many purposes where a cheap manufacture is wanted.

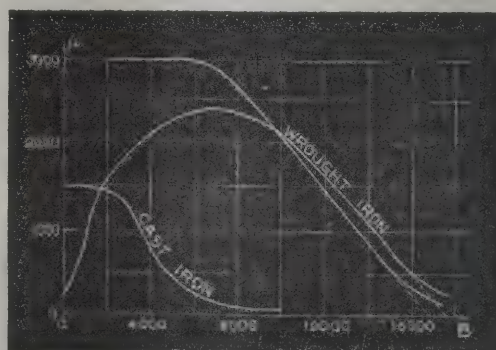


FIG. 20.—CURVES OF PERMEABILITY.

A very useful alternative mode of studying the results obtained by experiment is to construct curves, such as those of fig. 20, in which the values of the permeability are plotted out vertically in correspondence with the values of  $B$  plotted horizontally. It will be noticed that in the case of Hopkinson's specimen of annealed wrought iron, between the points where  $B = 7,000$  and  $B = 16,000$ , the mean values of  $\mu$  lie almost on a straight line, and might be approximately calculated from the equation:—

$$\mu = (17,000 - B) \div 3.5.$$

## THE LAW OF THE ELECTRO-MAGNET.

Many attempts have been made, by Müller, Lamont, Frölich, and others to discover a simple algebraic formula whereby to express the relation between the magnetising force and the magnetism produced in the electro-magnet. According to Müller, these are related to one another in the same proportions as the natural tangent is related to the arc which it subtends. The formulæ of Lamont and Frölich, which are more nearly in keeping with the facts, are based upon the assumption of a relation between the permeability and the degree of magnetisation present. Suppose we assume the approximation stated above, that the permeability

is proportional to the difference between  $B$  and some higher limiting value (17,000 for wrought iron, 7,000 for cast iron). If this higher value is called  $\beta$  we may write

$$\mu = \frac{\beta - B}{a},$$

where  $a$  is a constant that varies with the quality of the iron or steel

Now  $B = \mu H$ ;

giving by substitution and an easy transformation—

$$B = \beta \frac{H}{a + H},$$

which is one form of Frölich's well-known formula. The constant,  $a$ , stands for the "diacritical" value of the magnetising force, or that value which will bring up  $B$  to half the assumed limiting or "satural" value.

All such formulæ, however convenient, are insufficient, inasmuch as they fail to take into account the properties of the entire magnetic circuit.

(To be continued.)

## EDINBURGH EXHIBITION.

(Continued from page 205.)

No. 29.—Messrs. Laurence, Scott & Co., Limited, of Norwich, show on the stand of their agents for Scotland (Messrs. Norman & Son, Limited, Glasgow) among other things, one of their "D 7" dynamos driven by a long stroke engine by Messrs. Ransomes, Sims & Jefferies, of Ipswich. In this dynamo the magnets are of the "Kapp" type, made of specially soft cast iron, and the machine has three very long bearings. The magnets are very massive and the whole thing makes a perfectly rigid combination. The armature is built up on the system which Messrs. Laurence, Scott & Co., Limited, have used successfully for several years; it is a drum armature, and the plates are stamped with hexagonal holes placed, together with the insulating material between them, on a temporary hexagon mandril which, being removed, the hexagon spindle is driven into them very tightly with strips of vulcanised fibre to insulate the plates from the spindle. A section of this type of armature is shown with magnets of the "Manchester" type, from which it can be seen that the conductor is wound in deep and narrow slots milled into the plates.

The output of the machine is 110 volts, 140 ampères, at 1,160 revolutions per minute. There are 70 sections in the commutator, and 70 turns of conductor on the armature, so that there is only one turn of conductor per section. The armature core is nearly square in longitudinal section, being  $7\frac{1}{4}$  inches in diameter and  $7\frac{1}{2}$  inches long. The conductor on the armature consists of two parallels of  $\frac{1}{12}$  inch round wire braided, the resistance of the armature when hot, being .024 ohms. The shunt winding consists of 147 lbs. No. 17 wire, and the series of 73 lbs. No. 6 wire, in four parallels, there being 8,560 ampère turns in the shunt and 5,520 in the series, total number of ampère turns, 14,080. The watts lost in the field magnets are 408; the total electrical efficiency of the machine, 94.6 per cent. The total weight of conductor on the armature, including commutator connections, is only 21 lbs., being 733 watts per pound of copper.

There is also shown a ship-lighting plant by the same firm. The armature of the dynamo is of the same type as that of the belt-driven one described above. This construction of armature is specially applicable to these slow speed direct-driven machines, in which the strains between the shaft and the armature conductor are so much greater and more trying than in an ordinary belt-driven machine. The output of the dynamo is 60 volts, 75 ampères, at the slow speed of 260 revolutions per minute. Messrs. Laurence, Scott & Co. always test these ship lighters before leaving their works for 6 hours at "load and-a-half," and for 12 hours at full load. The engine is by

Messrs. Sabberton Bros., of Norwich. The crank is of forged steel, slotted and fitted with balance weights; the connecting rod is also of forged steel. All the bearings and wearing surfaces are very large and fitted with suitable lubricating arrangements to enable it to run continuously at a high speed. The cylinders are 6 inches diameter and 6 inches stroke, and the engine will run well up to 400 revolutions per minute.

## TELEPHONE CABLES.

UP to the year 1889, nearly every telephone company in the United States employed a different type of cable. These types differed not only in construction, number of conductors, methods of insulating and protecting, conduit systems, &c., but they also showed the widest variations in their insulation resistances. To remedy this inconvenience and to determine upon some uniform type of cable and a standard resistance, a conference was assembled in May 1889, in New York, at the invitation of the American Telephone and Telegraph Company (the Long Distance Telephone Company), an association which has generally taken the lead in all technical questions pertaining to telephony. The decisions arrived at by the conference were as follows:—

The cables should be composed of 50 double wires. The wires to be 1.025 mm. diameter of copper, the conductivity to be not less than 98 per cent. pure copper. Each wire should be covered with a double coating of braided cotton. The wires should be laid up in layers; in cables of 50 double wires the centre layer to be of three double wires, the next of 9, the next of 16 and the outside layer of 23 double wires. Each layer to be laid up in an opposite direction to the preceding one.

The cable thus formed should be placed in a pipe made of 97 per cent. lead and 3 per cent. tin. This mixture of tin with lead was adopted in order to preserve the latter from the injurious action of creosote. The vacant space in the pipe should then be filled with some insulating compound. The inductive capacity of each wire, after laying down, should not exceed 0.18 microfarads, and the insulation resistance should not be less than 100 megohms per mile. The pipes should be protected by a coating of asphalt, with an external covering of two layers of fibrous material, impregnated with some preservative compound, and laid on in opposite directions.

In the Patterson type of what was called the "conference cable," the insulating compound run into the pipe was paraffine impregnated with carbolic acid, and the external covering was of cotton tape. In the Faraday type of the same cable, pyroligneous oil was used as an insulator, and the cable was covered externally with jute impregnated with asphalt.

The price of the "conference cable" of 100 wires, was 70 cents per foot in New York, and the laying in conduits, in the same town, cost from 5 to  $7\frac{1}{2}$  cents the foot-run.

At the time the conference was assembled, experiments were being carried out by the Norwich Insulated Wire Company, with Manilla paper as a covering for the wires instead of cotton. It was claimed that a diminution of 30 per cent. in the inductive capacity was obtained by the employment of the paper, and that it was of a far less hygroscopic nature than cotton. The price was stated to be about the same as that of the "conference cable." The conference came to the conclusion that these experiments deserved every attention, since the question of inductive capacity formed so important an element in the working of telephone cables

## THE ELECTRIC LIGHTING OF TEPLITZ.

[FROM A CORRESPONDENT.]

As I recently informed you, the authorities of the Bohemian watering place have resolved not to renew the gas agreement which expires in August next, but to erect large municipal electric works. The official report of the committee for considering this project, contains on the one hand many interesting data on the comparative cost of electric lighting and of gas, and on the other hand communications and revelations which throw a very peculiar light upon the endeavours of gas companies to maintain their former position under all circumstances, and without any regard to the means employed.

I will, in the first place, give the proposals of the "Department of Works," which explain the estimates of comparative cost, in consequence of which the erection of the municipal electrical works was resolved on. They are as follows:—

According to the present and the probable circumstances of the town, the following data may be laid down:—

The renewal of the agreement for carrying out the lighting of the public streets and places with coal gas would in round numbers come to about 11,000 florins yearly. The lighting of the municipal buildings formerly named\* would require annually 1,950 florins, and private consumers would have to pay for the hourly service of a gas flame at 12 normal candles 2.88 kreuzers.

If the present public lighting is increased by 60 Wenham lamps, the town would have to pay, in addition to the above-named 11,000 florins, and besides the first cost of procuring and installing the lamps (5,175 florins), 2,500 florins annually.

If the public lighting of the town were carried out with the electric light according to the proposal of the Teplitz-Schönan Gas Company (July 9th, 1890), *i.e.*, with 484 glow lamps at 16 normal candles, and with four arc lamps at 10 ampères, the cost would run up to 18,594 florins 30 kreuzers. The light would then be stronger than it is at present by  $33\frac{1}{3}$ rd per cent. Private consumers, according as their consumption falls below 4,500 glow lights, above 4,500 or above 7,000 glow lights, would have to pay for the burning-hour of a 16-candle glow lamp, respectively,  $3\frac{1}{4}$ ,  $2\frac{1}{2}$  or 2 kreuzers, besides a fundamental tax of 5 florins for each glow lamp.

To the cost of the electric lighting of the municipal buildings in certain streets would be also added the same tax of 5 florins per glow lamp. The water for the central station would (within certain limits) have to be furnished gratuitously by the municipality.

If a combined lighting were introduced according to the offer of the gas company, under date July 29th, 1890, *i.e.*, 30 arc lamps at 10 ampères, in addition to the lights included in the proposals of July 9th, the outlay would amount to 21,500 florins yearly.

If the proposals of the management of Prince Olary's estates (May 15th, 1890), were accepted, *i.e.*, to light up the streets and squares with 16-candle lamps, equal in number (484) to the present 12-candle gas flames, or an increase of the light by one-third the yearly expenditure, would reach 19,078 florins 30 kreuzers.

Private consumers would then have to pay for the burning hour of a 16 normal candle glow lamp,  $3\frac{1}{2}$ ,  $2\frac{1}{2}$ , or 2 kreuzers in addition to the fundamental tax of 6 kreuzers per glow light.

If, lastly, the municipality erects an electric central station for 5,000 glow lamps at 16 normal candles, and keeps this installation in its own hands, the electric lighting of the public streets and places  $5\frac{1}{2}$  times more powerfully than at present, would come to 12,000 florins yearly, and that of the public buildings and theatres,

with a light increased by  $\frac{1}{3}$ rd, would come to 2,000 florins.

If application is made by private consumers for 3,000 glow lamps, there will be a clear profit of 12,000 florins yearly, or the cost of the public lighting will be compensated.

In addition, the municipality would be in a position to supply the inhabitants of Teplitz with electric current of a 16 normal candle glow lamp for 2 kreuzers per hour burning, *i.e.*, taking the strength of the light into account, for 50 per cent. cheaper than the previous gas light. The very cheap fundamental tax—3 florins per glow lamp, as against 5 and 6 florins of the two proposals—would make little difference. Thus, *e.g.*, a gas flame at 16 normal candles, calculated as burning 1,000 hours yearly, would come to 38 florins 40 kreuzers; if burning 450 hours, to 17 florins 28 kreuzers, whilst a glow light at 16 normal candles, in the first case, would cost only 23 florins, and in the second, only 12 florins, which shows an economy of 15 florins 40 kreuzers in the first case, and of 5 florins 28 kreuzers in the second case.

Considering the economical and financial conditions, and remembering how dangerous it would be for the town under present conditions to bind itself by an agreement extending for tens of years, and how injurious such a renewed agreement would be to the community who desire the cheap supply of a light on a level with the advances of the present day, the Department proposes that.

The representatives of the town should resolve:—

1. The municipality of Teplitz makes use of the right secured to it under Section 6 *f.* of the gas agreement of October 12th, 1860, not further to renew the contract entered into with the Teplitz-Schönan Gas Company.

2 (a). The municipality of Teplitz erects an electric central station of the provisional capacity of 5,000 glow lamps of 16 normal candles (burning simultaneously), for lighting up the public streets and places and the municipal buildings, including the theatre, and for supplying electric current to private consumers.

(b). That a credit of 300,000 florins be granted for this purpose.

(c). That the Finance Committee is authorised to make proper arrangements for procuring this sum.

(d). The construction of this central installation is entrusted to the mayor, in conjunction with the committee of works, just as was the case in the construction of the town waterworks.

3. All the proposals for renewing the gas agreement, or for introducing any other kind of lighting, made by the gas company, or by the inspection of Prince Olary's estates, are declined with thanks.

4. The Mayor is requested to negotiate with the Teplitz-Schönan Gas Company, and to ascertain if, and on what conditions, they are disposed to prolong their agreement for five months, that is, to the end of the year 1891.

The report mentions, further, that the gas company seeks on the one hand to deny the right of the town to break off the agreement, and on the other hand it claims for itself the exclusive right to use the municipal territory for laying down light conductors of whatever kind (therefore including electric light leads).

As regards the latter question, it must be pointed out that in the year 1858 the town made an agreement with the gas company, and conceded to the latter the exclusive right of laying down the mains and branch pipes required for lighting the streets, public and private buildings, in the squares, streets and lanes of the territory of the town of Teplitz.

The sector concerned makes mention simply of *main* and *bye-pipes*, and not expressly of gas pipes. But the object of the entire agreement is simply gas lighting, to which all the mutual rights and duties are referred. In particular the word *pipes* refers formally to gas conductions which are laid as pipes. Still, the gas company now seeks to extend the exclusive right, granted in the year 1858, to electric leads, regardless of the fact that such leads are not pipes, and that it con-

\* Not in the present report.

sequently can raise no claim to them, even in the simple sense of the words.

The former question raised is still more interesting, *i.e.*, that as to the right of setting aside the agreement for public lighting. This question turns upon section 6 of the agreement, which runs as follows:—

"The municipality shall, however, at any time have the option, after the expiry of the first 20 years, to arrange for its own lighting, and on other illuminating material, if it considers that such will be cheaper, and, therefore, entirely to renounce this agreement after the lapse of the first 20 years."

Hence it appears that the town has the right at any time after the lapse of the first 20 years to withdraw from the agreement. The gas company has, indeed, already recognised this right in a proposal handed in on November 30th, 1889, for lighting the streets of Teplitz from August 1st, 1891, to July 31st, 1901. In this document we read:—

"In considering our present proposal, we beg to point out that according to section 6 *f* (quoted above) of the agreement, extending to the year 1911, the municipality is, indeed, entitled from August 1st, 1891, to undertake its own lighting with another illuminating material; but, in this case, it cannot be demanded that the gas company should undertake the gas lighting for the other streets at the previous price of 20 florins yearly per burner."

Nevertheless, the gas company, now threatened with the competition of a municipal electrical works, ventures on the impossible interpretation that the town Teplitz had the right of withdrawing from the agreement *only after the first 20 years*, but has lost this right, as it has not put it in force after the first 20 years. In other words, that it could have enforced this right only at the immeasurable moment of the lapse of the first 20 years.

It may be taken for granted that gas companies cannot carry the day by dint of such ultra-pettifogging constructions. It was certainly superfluous to combat and to refute the pretensions of the Teplitz Gas Company in a pamphlet of 18 pages; but it is instructive to see what we may expect on the part of gas companies, and how cautious town councils should be in drawing up agreements concerning lighting.

## CORRESPONDENCE.

### The Bremen Electric Tramway.

We have read on page 319 of the REVIEW of September 19th, an editorial note to the effect that we have experienced a rebuff on the part of the Bremen Town Council, and that the tramway has worked unsatisfactorily.

Wherever you obtained this information, it is absolutely incorrect, and is exactly what was said by the *Elektro-Technischen Anzeiger*, of Berlin, in their publication of September 4th.

Aside from the letter of correction which we immediately addressed to the Berlin journal, the Bremen Tramway Company, for whom we have made the electrical equipment in question, wrote as follows:—

"To the Editor of the *Elektro-Technischen Anzeiger*,  
"Berlin.

"In No. 71 of your esteemed journal, there is an article as follows:—

"The request of the Thomson-Houston Company to erect an electric railway in Bremen was refused, because the trial plant did not satisfy the conditions during the Exhibition."

"The undersigned Share Company, which has the concession for the line Börse to Bürgerpark (Exhibition), which road was installed by the Thomson-Houston International Electric Company, is directly interested that the shareholders be not led to believe the untrue statements contained in this article, to the

effect that this plant is a failure; further, that the public be not deterred, by mistaken or false statements in this article from using this electric road.

"We therefore request you, on the basis of Sec. 11 of the Press Law, to insert in your esteemed paper the following corrections:—

"1. It cannot be said that the demand of the Thomson-Houston Company was refused, because the Tramway Company has the allowance for electric running at present during the time of the Exhibition, and up to date the Thomson-Houston Company have never asked the municipality in question for permission to continue running this road.

"2. It is further stated in your article:—

"A specially objectionable feature is the unbearable rattling noise, and the strong sparking between wheels and rails."

"The statement as to the unbearable rattling noise, is only an invention of the writer of the article, and the sparking is not stronger than with any electric road when the rails are not free from sand. The sparking is even considered to be minimum by all experts, and this electric road is so much liked by the public that they decidedly prefer the electric cars to the horse cars, notwithstanding the somewhat higher fare.

"The article mentions the whole plant as defective, but, as a matter of fact, during the now nearly three months' operation, not the slightest disturbance has happened which could be referred to the T.H.I.E. Co. The substantial, simple and practical manner in which all the details are carried out, deserves our entire approbation. The whole installation is an excellent one, and finds great favour with all experts, as well as with the public.

"We give you this detailed explanation in order to prevent the misleading of the public by the article in your much read paper, and are convinced that you will correct such untrue statements made in the article in question.

"(Signed)

"BREMER PFERDEBAHN-GESELLSCHAFT."

The facts of the case are that the road has been running continuously ever since June 23rd, and during that time the five motor cars, with occasional tow-cars, have carried over 453,491 paying passengers, not counting other passengers whose tickets, paid for on other divisions of the line, have entitled them to continue the trip over the electric line, and not including those having season tickets or free cards.

There have been no interruptions to the service due to electrical causes.

Inasmuch as the Society of Engineers and Architects of Germany, after their general meeting in Hamburg, also visited the Bremen Exhibition in great numbers, and inasmuch as Bremen has been the seat of the annual meeting this year for the Physical Society of Germany, and the Exhibition itself being one of great merit, especially as to engineering details, has attracted many eminent technical men of North Europe, especially many practical street railway men, there has been ample opportunity for criticism and free expression of opinion regarding the tramway there, but in all the conversations that we have had with such judges, and all the notices that we have seen in the German press, adverse criticism has been lacking.

Thomson-Houston International Electric Co.

LOUIS J. MAGEE.

September 26th, 1890.

### Electricity v. Gas.

I have read with great interest the article in last week's ELECTRICAL REVIEW *re* "The Relative Cost of Gas and Electricity in Cotton Mills," and which, no doubt, many of your subscribers have also read; but do you not think that this is far from what the average maintenance would be? It strikes me that it is much

too low. Take, for instance, coal. Where outside of Lancashire would you be able to get coal at 5s. per ton average for 6 years? This is, in my opinion, extremely low and somewhat misleading. I also observe that the power is put down at £150, or £5 per H.P. I presume this is the engine alone, if so what is the boiler worth, and what is the depreciation thereon. I should also suggest that something should be taken from the engineer's account and put to the maintenance account, as I fail to see that the management of an installation of this size should cost practically nothing. Surely the time putting new lamps on alone should make a slight difference.

A. Handley.

September 22nd, 1890.

#### Tesla's New Alternating Motors.

The following communication, which Mr. Tesla has sent to the New York *Electrical Engineer*, he desires should also appear in the REVIEW:—

I hope you will allow me the privilege to say in the columns of your esteemed journal a few words in regard to an article which appeared in *Industries* of August 22nd, to which my attention has been called. In this article an attempt is made to criticise some of my inventions, notably those which you have described in your issue of August 22nd, 1890.

The writer begins by stating: "The motor depends on a shifting of the poles under certain conditions, a principle which has been *already*\* employed by Mr. A. Wright in his alternating current meter." This is no surprise to me. It would rather have surprised me to learn that Mr. Wright has *not yet* employed the principle in his meter, considering what, before its appearance, was known of my work on motors, and more particularly of that of Schallenberger on meters. It has cost me years of thought to arrive at certain results, by many believed unattainable, for which there are now numerous claimants, and the number of these is rapidly increasing, like that of the colonels in the South after the war.

The writer then good-naturedly explains the theory of action of the motive device in Wright's meter, which has greatly benefited me, for it is so long ago since I have arrived at this and similar theories that I had almost forgotten it. He then says: "Mr. Tesla has worked out some more or less complicated motors on this principle, but the curious point is that he has completely misunderstood the theory of the phenomena, and has got hold of the old fallacy of screening." This may be *curious*, but how much *more curious* it is to find that the writer in *Industries* has *completely misunderstood* everything himself. I like nothing better than just criticism of my work, even if it be severe, but when the critic assumes a certain "l'état c'est moi" air of unquestioned competency I want him to know what he is writing about. How little the writer in *Industries* seems to know about the matter is painfully apparent when he connects the phenomenon in Wright's meter with the subject he has under consideration. His further remark, "He (Mr. Tesla) winds his secondary of iron instead of copper and thinks the effect is produced magnetically," is illustrative of the care with which he has perused the description of the devices contained in the issue of the *Electrical Engineer* above referred to.

I take a motor having, say, eight poles, and wrap the exciting coils of four alternate cores with fine insulated iron wire. When the current is started in these coils it encounters the effect of the closed magnetic circuit and is retarded. The magnetic lines set up at the start close to the iron wire around the coils, and no free poles appear at first at the ends of the four cores. As the current rises in the coils more lines are set up, which crowd more and more in the fine iron wire until finally the same becomes saturated, or nearly so, when

the shielding action of the iron wire ceases, and free poles appear at the ends of the four protected cores. The effect of the iron wire, as will be seen, is two-fold. First, it retards the energising current; and, second, it delays the appearance of the free poles. To produce a still greater difference of phase in the magnetisation of the protected and unprotected cores, I connect the iron wire surrounding the coils of the former in series with the coils of the latter, in which case, of course, the iron wire is preferably wound or connected differentially, after the fashion of the resistance coils in a bridge, so as to have no appreciable self-induction. In other cases I obtain the desired retardation in the appearance of the free poles on one set of cores by a magnetic shunt, which produces a greater retardation of the current and takes up at the start a certain number of the lines set up, but becomes saturated when the current in the exciting coils reaches a predetermined strength.

In the transformer the same principle of shielding is utilised. A primary conductor is surrounded with a fine layer of laminated iron, consisting of fine iron wire or plates properly insulated and interrupted. As long as the current in the primary conductor is so small that the iron enclosure can carry all the lines of force set up by the current there is very little action exerted upon a secondary conductor placed in vicinity to the first; but just as soon as the iron enclosure becomes saturated, or nearly so, it loses the virtue of protecting the secondary, and the inducing action of the primary practically begins. What, may I ask, has all this to do with the "old fallacy of screening?"

With certain objects in view—the enumeration of which would lead me too far—an arrangement was shown in the *Electrical Engineer*, about which the writer of *Industries* says:—"A ring of laminated iron is wound with a secondary. It is then encased in iron laminated in the *wrong direction*, and the primary is wound outside of this. The layer of iron between the primary and secondary is supposed to 'screen' the coil. Of course it cannot do so; such a thing is unthinkable." This reminds me of the man who had committed some offence, and engaged the services of an attorney. "They cannot commit you to prison for that," said the attorney. Finally the man *was* imprisoned. He sent for the attorney. "Sir," said the latter, "I tell you they *cannot* imprison you for that." "But, sir," retorted the prisoner, "they *have* imprisoned me." It *may not* screen, in the opinion of the writer of *Industries*, but just the same it *does*. According to the arrangement, the *principal* effect of the screen may be either a retardation of the action of the primary current upon the secondary circuit, or a deformation of the secondary current wave with similar results for the purposes intended. In the arrangement referred to by the writer of *Industries* he seems to be certain that the iron layer acts like a choking coil; there again he is mistaken; it does not act like a choking coil, for then its capacity for maintaining constant current would be very limited. But it acts more like a magnetic shunt in constant current transformers and dynamos, as, in my opinion, it ought to act.

There are a good many more things to be said about the remarks contained in *Industries*. In regard to the magnetic time lag, the writer says: "If a bar of iron has a coil at one end, and if the core is perfectly laminated, on starting a current in the coil the induction *all along the iron* corresponds to the excitation at that instant, unless there is a microscopic time lag, *of which there is no evidence*." Yet a motor was described, the very operation of which is dependent on the time lag of magnetisation of the different parts of a core. It is true the writer uses the term "perfectly laminated" (which, by the way, I would like him to explain), but if he intends to make such a "perfectly laminated" core, I venture to say there is trouble in store for him. From his remarks I see that the writer completely overlooks the importance of the size of the core and of the number of the alternations pointed out; he fails to see the stress laid on the saturation of the screen, or shunt, in some of the cases described; he does not seem to recognise the fact that in the cases considered the

\* All italics are mine.

formation of current is reduced as far as practicable in the screen, and that the same, therefore, so far as its quality of screening is concerned, has no rôle to perform as a conductor. I also see that he would want considerable information about the time lag in the magnetisation of the different parts of a core, and an explanation why, in the transformer he refers to, the screen is laminated in the *wrong direction*, &c.—but the elucidation of all these points would require more time than I am able to devote to the subject. It is distressing to find all this in the columns of a leading technical journal.

In conclusion, the writer shows his true colours by making the following withering remarks: "It is questionable whether the Tesla motor will ever be a success. Such motors will go round, of course, and will give out-puts, but their efficiency is doubtful; and if they need three-wire circuits and special generators there is no object in using them, as a direct current motor can be run instead with advantage."

No man of broad views will feel certain of the success of any invention, however good and original, in this period of feverish activity, when every day may bring new and unforeseen developments. At the pace we are progressing the permanence of all our apparatus in its present forms becomes more and more problematical. It is impossible to foretell what type of motor will crystallise out of the united efforts of many able men; but it is my conviction that at no distant time a motor having commutator and brushes will be looked upon as an antiquated piece of mechanism. Just how much the last-quoted remarks of the writer of *Industries*—considering the present state of the art—are justified, I will endeavour to show in a few lines.

First, take the transmission of power in isolated places. A case frequently occurring in practice and attracting more and more the attention of engineers is the transmission of large powers at considerable distances. In such a case the power is very likely to be cheap, and the cardinal requirements are then the reduction of the cost of the leads, cheapness of construction and maintenance of machinery and constant speed of the motors. Suppose a loss of only 25 per cent. in the leads, at a full load, be allowed. If a direct current motor be used, there will be, besides other difficulties, considerable variation in the speed of the motor—even if the current is supplied from a series dynamo—so much so that the motor may not be well adapted for many purposes, for instance, in cases where direct current transformation is contemplated with the object of running lights or other devices at constant potential. It is true that the condition may be bettered by employing proper regulating devices, but these will only further complicate the already complex system, and in all probability fail to secure such perfection as will be desired. In using an ordinary single-circuit alternate current motor the disadvantage is that the motor has no starting torque and that, for equal weight, its output and efficiency are more or less below that of a direct current motor. If, on the contrary, the armature of any alternator or direct current machine—large, low-speed, two-pole machines will give the best results—is wound with two circuits, a motor is at once obtained which possesses sufficient torque to start under considerable load, it runs in absolute synchronism with the generator—an advantage much desired and hardly ever to be attained with regulating devices; it takes current in proportion to the load, and its plant efficiency within a few per cent. is equal to that of a direct current motor of the same size. It will be able, however, to perform more work than a direct current motor of the same size, first, because there will be no change of speed, even if the load be doubled or tripled, within the limits of available generator power; and, second, because it can be run at a higher electromotive force, the commutator and the complication and difficulties it involves in the construction and operation of the generators and motors being eliminated from the system. Such a system will, of course, require three leads, but since the plant efficiency is practically equal to that of the direct current system, it will require the

same amount of copper which would be required in the latter system, and the disadvantage of the third lead will be comparatively small, if any, for three leads of smaller size may perhaps be more convenient to place than two larger leads. When more machines have to be used there may be no disadvantage whatever connected with the third wire; however, since the simplicity of the generators and motors allows the use of higher electromotive forces, the cost of the leads may be reduced below the figure practicable with the direct current system.

Considering all the practical advantages offered by such an alternating system, I am of an opinion quite contrary to that of the author of the article in *Industries*, and think that it can quite successfully stand the competition of an direct current system, and this the more the larger the machines built, and the greater the distances.

Another case frequently occurring in practice is the transmission of small powers in numerous isolated places, such as mines, &c. In many of these cases simplicity and reliability of the apparatus are the principal objects. I believe that in many places of this kind my motor has so far proved a perfect success. In such cases a type of motor is used possessing great starting torque, requiring for its operation only alternating current, and having no sliding contacts whatever on the armature, this advantage over other types of motors being highly valued in such places. The plant efficiency of this form of motor is, in the present state of perfection, inferior to that of the former form, but I am confident that improvements will be made in that direction. Besides, plant efficiency is, in these cases, of secondary importance, and in cases of transmission at considerable distances, it is no drawback, since the electromotive force may be raised as high as practicable on converters. I cannot lay enough stress on this advantageous feature of my motors, and should think that it ought to be fully appreciated by engineers, for to high electromotive forces we are surely coming, and if they must be used, then the fittest apparatus will be employed. I believe that in the transmission of power with such commutatorless machines, 10,000 volts, and even more, may be used, and would be glad to see Mr. Ferranti's enterprise succeed. His work is in the right direction, and, in my opinion, it will be of great value for the advancement of the art.

As regards the supply of power from large central stations in cities or centres of manufacture, the above arguments are applicable, and I see no reason why the three-wire motor system should not be successful. In putting up such a station, the third wire would be but a very slight drawback, and the system possesses enough advantages to over-balance this and any other disadvantage. But this question will be settled in the future, for as yet comparatively little has been done in that direction, even with the direct-current system. The plant efficiency of such a three-wire system would be increased by using, in connection with the ordinary type of my motor, other types which act more like inert resistances. The plant efficiency of the whole system would, in all cases, be greater than that of each individual motor—if like motors are used—owing to the fact that they would possess different self-induction, according to the load.

The supply of power from lighting mains is, I believe, in the opinion of most engineers, limited to comparatively small powers, for obvious reasons. As the present systems are built on the two-wire plan, an efficient two-wire motor without commutator is required for this purpose, and also for traction purposes. A large number of these motors, embodying new principles, have been devised by me and are being constantly perfected. On lighting stations, however, my three-wire system may be advantageously carried out. A third wire may be run for motors and the old connections left undisturbed. The armatures of the generators may be re-wound, whereby the output of the machines will be increased about 35 per cent., or even more, in machines with cast iron field magnets. If the machines are worked at the same capacity, this

means an increased efficiency. If power is available at the station, the gain in current may be used in motors. Those who object to the third wire, may remember that the old two-wire direct system is almost entirely superseded by the three-wire system, yet my three-wire system offers to the alternating system relatively greater advantages than the three-wire direct possesses over the two-wire. Perhaps, if the writer in *Industries* would have taken all this in consideration, he would have been less hasty in his conclusions.

Nikola Tesla.

New York, September 10th, 1890.

#### Re Mr. Varley's New Photometer.

I have been much interested in reading the account of the new photometer invented by Mr. F. H. Varley; and it is almost unnecessary to say that it is superior to the older forms in several respects; but as I have been engaged in experimenting for some time past over a similar project, I trust my intentions may not be misunderstood in querying the absolute "mathematical" accuracy with which measurements may be conducted by means of this apparatus.

Errors which exist in the Bunsen photometer would, I believe, be found to occur, although possibly to a far lesser extent, in this instrument, due to the following causes:—

- (1.) Spectral disparity between the two radiants.
- (2.) Irregularity of luminous intensity of the standard.
- (3.) Inability of the human eye to estimate exactly when the neutralising action of the discs comes into play, for, it must be remembered, that in estimating the difference between, say, a white and a pale grey, the eye is not possessed of sensitive properties in a very exalted degree. This by itself would be but a trifling error, but might become more important if error No. 1 existed.

(4.) Faulty adjustment of the mutual screen distance in regard to the two radiants.

(5.) Slight external vibration or irregularity of rotation of the discs would tend to increase this error when the light to be measured has great luminosity compared with the standard, owing to the necessary disparity of slot width in such cases.

It will, I trust, be conceded that my intentions in pointing out what defects I believe to exist in this apparatus are not in any way due to mercenary ends, as I am not very desirous of commercially developing the instrument whose completion I expect shortly, and whose perfection (if it be found to possess such) is largely due to the friendly critique of the design of a former apparatus by Mr. S. A. Varley, the brother of the inventor of the apparatus under discussion, which differs entirely in design from my own.

Ralph Richards.

#### Electrical Heterodoxy.

Your correspondent, Mr. Henry Sutton is a maker of logomachies, and something more than this. He writes: "It does not follow that because we speak of + and — electrification and polarisation that we believe, or even assume, there are two electricities." Faraday was not so foolish as to attempt to describe that which he called induction or polarisation of glass without assuming that there were two electric forces to produce the effect; but what Mr. Sutton means by induction and polarisation of glass without assuming that there are two electric forces to produce them, is beyond my comprehension.

Mr. Sutton writes: "Assuming the spark an evidence of conduction, and its passage an evidence of current, then if the conduction is absolute, the glass should be perforated." Mr. Sutton would not have written this

if he had studied the difference between Faraday's theory of electricity and mine; but Mr. Sutton has rushed into print without reading my book. Glass is a porous body; through some kinds of it electricity passes with perfect freedom because the pores in it are so large that the particles of the electric matter can pass through without obstruction, and, consequently, without disrupting the glass; but there are other kinds of glass the pores in which are not so large as to allow all the particles of a current of electricity to pass immediately through without some obstruction, and hence a Leyden jar becomes charged. The reasons for this I have assigned at length in my book, to which I must refer Mr. Sutton.

James Johnstone.

September 29th, 1890.

#### A Recommendation.

An Electrical Directory is just now collecting its information amongst the electrical and allied trades, but I think it will be news to the many eminent inventors and manufacturers who by right are included in its pages to learn that, judging by the issue of last year, they are exposed to classification with such specialists as Mr. C. B. Harness and Mr. Edward Moross, and such leading manufacturers as Messrs. Constantine and Jackson, whose announcements are usually to be met with in those public edifices occupying advantageous sites in the centres of many of our principal thoroughfares, either above or below the surface.

I would take this opportunity of recommending the author and compiler of this directory to delete such persons, it would hardly make his book less *burly*.

Anti-Harness.

#### Ship Wiring.

The writer of the comments on the heating of the electric light leads in the ss. *Etruria*, is evidently not practically acquainted with either single wiring, double wiring, or any other wiring systems for ship lighting. I have fitted out over a hundred steamships with electric light, some double wired and some single wired—mostly single wired—and my experience goes to prove that single wiring is the most expensive system, when carried out properly, and is very much safer as regards fire risks and breakdown.

For single wiring on board ship, only iron armoured vulcanised rubber insulated copper wires should be used, with malleable cast iron junctions; lead sheathing and wood casing is not good enough, except for branches to each lamp in the cabins, saloons, &c. As to fuses, I have known instances where a No. 20 lead fuse had been replaced by a No. 16 copper wire, and no doubt many fusible plugs are rendered valueless by careless replacing of the fuse by heavy copper wire. Everyone knows that a short-circuit on a ship is not at all dangerous if there are workable fuses in all branches, and the danger is all in either not having fuses all or in having a fuse spoiled by the insertion of a good thick copper wire.

Cheapness has ruined the business of ship lighting. In fact, in some cases, it is advisable not to offer for such work at all rather than put in the cheap installations that are sometimes desired; but, in fact, a single wired installation is dearer than a double wired one, the saving in copper being more than balanced by the extra labour in hole boring, and by the cost of iron wire sheathing and iron junctions. The fittings are much safer having only one wire in them, and centre contacts can be used throughout, the insulation being nowhere subjected to cutting or abrasion as is the case in double wired fittings, where the wires are pulled through and fixed into holders by screws.

R. Kennedy.

September 29th, 1890.

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## THE LABOUR QUESTION.

TRADES unionism, which has given us many varied and altogether unpleasant experiences, has seldom shown its true character so distinctly as during the last week, and it is somewhat humiliating, as Englishmen, to be obliged to confess that the qualities of the labouring man, as a unionist, most prominently brought into notice—that is to say, if he be rightly represented by his spokesmen—are those of a bully, a sneak, and a perverter of the truth. By this time there must be but very few persons sanguine enough to still place any faith in the word or bond of the British workman. This is not very pleasant talking, but it is impossible to come to any other conclusion after a consideration of the events of, let us say, the last twelve months. For the moment, indeed, difficulties seem to be tided over, but at any instant and, as it is now made public with almost brutal cynicism, without any preliminary warning, employers may find their works bare of men, their cargoes awaiting to be unloaded, their machinery standing idle, and their steamers detained for want of coal.

It would really seem hopeless to expect the arrival of the day when it will be brought home to the labouring man that if capital be prevented from obtaining labour in one locality it will surely succeed in meeting with it elsewhere, and that, just as certainly, if capital be debarred from an outlet in one direction, it cannot be idle, but must seek a course for its natural functions under other more favourable circumstances and conditions.

The difficulties with which trades unions are seeking to surround the free employment of labour and an untrammelled development of industry, can have but one result—the alienation of capital, and consequently of work; indeed, the present effects are serious enough, without borrowing any possibilities from the future. The docks and river strikes have already diverted an enormous amount of business from the Thames, and, with more particular reference to that trade organisa-

tion which has been trying to play a lone hand, large contracts have been recently made with firms in the Canary Islands for the supply of coal for a long period to certain important lines of steamers. This is a more serious matter than would at first appear, for although it is at present only a question of coaling ships, it is the first step towards the building up, at the expense of the labouring man in England, of alien enterprise and industry.

Amidst the labouring population there surely must be men of clear sight and sound judgment, and it seems strange that these cannot appreciate the fact that the cry of “capital *versus* labour” is nothing but a catchword, and beyond serving, for the want of a better, the purpose of a party-cry, is absolutely meaningless. Capital must, perforce, be brought into utilisation by means of labour, and if muscle cannot be depended upon to fulfil its engagements, one consequence, among others, overlooked to a great extent because the effects are not immediately appreciable, is that the incentive to perfecting labour-saving appliances receives increased stimulus.

No one could for a moment attempt to deny the misery existing among some of the working classes, and it is brought into the stronger relief from the squalor of their surroundings and the utter improvidence of their habits. The stern and immutable law of nature that the weakest must succumb in the struggle for existence is nowhere so painfully evident as in our teeming population, our overcrowded districts. The labouring classes can no more expect to be exempt from this law than any other order; the strongest, mentally or physically, must eventually push to the front. Any attempt to bolster up the weak and incapable can only result in the lowering of the general average, and this is precisely what will happen if the inefficient workman is to be paid the same as the capable. The survival of the fittest may sound a heartless axiom, but it indicates the only sound and healthy condition of society. The bringing of all labour to an equality in remuneration

is an attempt to promote the welfare of the ignorant and thriftless at the expense of the competent and ambitious; it would eliminate competition, which is the life and soul of all progress, individual or national; and reduce mental and physical faculties to a dull dead level of mediocrity.

The subject is one we have repeatedly brought before our readers, and, unfortunately, the occasion is too frequently given to us of reverting to the ill-directed struggles of the working man to assert his independence, and to the attempts of party leaders to subvert the natural laws of supply and demand to illegitimate ends.

### MORE ELMORE.

"IT looks as if Baron Grant is coming to the fore again. We understand that the Baron has had a good deal to do with bringing out some of the Elmore copper companies. City men used to say that he could draw up a prospectus better than any man in London."

The *Star* of Saturday last is responsible for the foregoing.

If any explanation were needed for again referring to the subject, it would suffice to say that the Baron is not likely to leave a fruitful field untilled.

"Kings can titles give, but honours can't,  
Title without honour is a barren grant."

We are sorry that the Baron has taken electrical ventures under his wing. Mines were at one time his favourites. Through the "Emma" the public lost a considerable sum, though very important names were on the board. It was, we believe, the action of Rubery v. Grant which led to the fall of a Sampson, and journalists will not soon forget the circumstances which preceded the placing of "Printing House Square" at the head of the *Times* money article. Association with the Baron has hitherto boded ill.

So long as Elmore companies can be successfully floated, Elmore companies will be issued. We hold it to be the duty of those who can in any way throw light upon the subject not to spare any trouble in doing so. The bases of the issues are prospectuses, reports, and patents. We purpose examining these in their order, with a view to discover their salient features. To-day we deal with the prospectuses.

Following is a list of the companies already floated, with the amounts of capital issued, and the prices paid for their rights:—

Company.	Capital issued.	Purchase Price.	
		Cash.	Shares.
Elmore Co. (British) ...	£140,000	£53,400	£46,600
Elmore Wire ...	200,020 }	75,000 }	20
Premium ...	100,000 }	50,000 }	
Elmore Co. (Foreign and Colonial) ...	120,000	80,000	30,000
Elmore Co. (French) ...	200,000 }	83,500 }	66,500
Premium ...	33,375 }	33,375 }	
Elmore Co. (Austro-Hungarian) ...	200,000 }	50,000 }	50,000
Premium ...	37,500 }	37,500 }	
	£1,030,895	£462,775	£193,120
		£655,895	

It will be seen that of the capital issued more than half has been paid away for rights, and that the vendors have a preference for cash. It may be noted, too, that the vendors to the Wire Company were content with half the premiums. The vendors to the French and Austrian Companies took all the premiums.

The patentees, or original vendors, received in cash and shares from the British and Foreign and Colonial Companies £210,000.

The British Company paid £100,000, and received from the Wire Company, for a partial license, £125,020.

The Foreign and Colonial Company paid £110,000, and received from the French and Austro-Hungarian Companies £320,875.

The five companies have 29 directorships. Fifteen gentlemen fill these. Mr. William Elmore is a director of four companies. Four other gentlemen are directors of four; two of two.

Messrs. F. E. and A. S. Elmore are either joint works managers, or joint consulting metallurgical chemists, to all the companies, without exception.

One gentleman acts as secretary of all the companies, without exception.

The prospectuses are nearly all alike, as we pointed out last week. The compilers of the original must be credited with having fairly exhausted the subject, including the Bessemer comparison. One of those points which strike us, on a reperusal of the prospectuses, is the sudden way in which a series of conjectures or estimates becomes "the above plain statement of facts."

Tracing the estimates in the later prospectuses back to their source, we find that in the Wire Company's prospectus it is stated that the estimate of cost of manufacture has been prepared by Mr. William Elmore.

It therefore comes down to this, that the figures upon which the directors base their calculations are the figures of one of the original vendors; the managers of the works in which any practical work may have been done being also among the original vendors.

The question we are naturally inclined to ask the directors is, whether, in a matter of such importance, it is altogether wise to base so much on the estimates of those who might reasonably be expected to develop a sanguine temperament.

A Record.

"SINCE then electricity comes not from the sun as from a heated body, it comes from its home the bowels of the earth. When God first created everything beautiful in its time (Eccles. iii.) as well for man's needs as to reflect his own glory, He placed latent heat, electric fire, in the centre of the earth as its nucleus, to radiate from the centre to the circumference, and to thereby hatch and vivify and cause to grow everything to which He had imparted life." "When the collapse of the eggshell crust (of the earth) comes, it will not be from the atmosphere from above driving it into a vacuum from below, which could not exist, but the presence of the fires and electricities of the earth, chockfull of them,

overcoming the resistance of the lighter electricity in the atmosphere above and its vacuums and universal cyclones." The above are not extracts from the works of Roger Bacon, or Paracelsus, but from a letter written by T. W. Christie, B.A. (Camb.), to the *Liverpool Courier* of Wednesday last, with the view of expounding to the readers of that journal, "where electricity comes from." In the same letter Mr. Christie propounds the theory that the sun is not hot, but shines and warms by reflected light and heat. We should not be surprised to hear that Mr. Christie believes that the earth is flat, or that the earth is the centre of the solar system. Considered as a sample of "newspaper science," Mr. T. W. Christie's letter has, we think, made a record.

Elmore Wire.

A WELL-KNOWN electrical expert who, if we mistake not, has taken a prominent part in testing Elmore copper wire, is stated to have said that under precisely similar mechanical conditions its conductivity is better by 2 per cent. than any other copper, electrically deposited or otherwise, with which he was acquainted. This slight difference is not likely to cause rival manufacturers much serious inconvenience, as we have previously pointed out a manner by which compensation may be made for any such small deficiency in conducting power. Moreover, we have yet to learn at what price this "extra high conductivity" wire can be put on the market.

National Telephone  
Company. A High-  
handed Policy.

A MR. ERSKINE MUIRHEAD, writing to a provincial newspaper, complains of a high-handed proceeding on the part of the National Telephone Company. It appears that Mr. Muirhead, at the request of the company, brought over to this country several telephones of the Ader and Berthon type; immediately afterwards Mr. Muirhead received a note from the company saying that the telephones in question were a direct infringement of their patents, and unless they were returned to France at once an action at law would result. If the facts are as stated, a more gross case can hardly be imagined; but we cannot but think that Mr. Muirhead has not fairly represented what has actually happened, for it would only be necessary to prove in Court that the company had invited Mr. Muirhead to bring over the instruments, for the action to be dismissed with costs. Mr. Muirhead also complains that, as a consequence of the dispute apparently, he was cut off from the Telephone Exchange, although he had signed the usual contract, under which he had the right to a further year's use of the privilege. The cause of all this is stated to be that the Ader-Berthon telephone is much superior to the existing apparatus, and that were it once tried by the public there would be a general demand all round for its adoption. Mr. Muirhead states that "as the patent will expire in a few days, he will be glad to fix a pair in the office of the provincial journal in question;" he does not state to what patent he refers, but inasmuch as the Edison patent, which has practically been held to cover the use of carbon, does not expire till July of

next year, it is difficult to see what right he has to fix the telephones in question in a few days. At the commencement of his letter Mr. Muirhead states that the Ader and Berthon telephones are in daily use, speaking between towns over 600 miles apart, this, we presume, being brought forward as an argument for the superiority of the instrument; as a matter of fact, it ought to be pretty well known now that to speak over 600 miles is not such a very marvellous feat, as the question is not one of instruments but of a sufficiently large copper wire. The Blake instrument, as used by the telephone companies, is not a satisfactory apparatus, as it requires careful adjustment to make it work properly; there are plenty of microphonic transmitters of simple design which are more efficient and require no adjustment whatever, but to substitute these would involve very great expense.

The Elmore  
Copper Company.

THOUGH our remarks in another column bear on some of the points raised by "a shareholder," we think it may be well to deal with them here *serialim*. We gave, as we think, good reasons for raising the question of justification for companies in some countries, even assuming the success of the process—say, in England—so we need not follow our correspondent into the regions of political economy. We are awaiting the proofs which our correspondent takes for granted in the next paragraph, and we are obliged to differ with him in his logic of criticism. "A shareholder" has reached the nutshell; we want to get at the kernel! We do not doubt that Elmore shareholders will consider our six columns might have been devoted to better purpose; at the same time, they will perhaps allow that we are the better judges on that point, for we attach no importance to the company's guarantees of their manufactures at present. Our correspondent should be aware that we do not condemn without enquiry. We are enquiring, and we have not condemned the invention, but we do condemn most strongly the promotion of sub-companies, and the payment of large sums for the invention in its present stage. "A shareholder's" second point may be left to the common sense which settles things "on evidence which cannot be fairly disputed." The statement that Mr. Clark was not referring to Elmore copper we take to mean, also, that he was not referring to copper "made in the same way as Elmore copper." If this be so it is of value, and we are much obliged to our correspondent for pointing it out. We shall bear it in mind in our further enquiries, but so far as our last week's article is concerned Mr. Clark's evidence may be removed from it entirely without modifying in any way the conclusions at which we arrived. We attach no importance whatever to the fact that Mr. Parker has become a shareholder. Without being quite sure that we understand the intent of his concluding paragraph, we imagine that "a shareholder" thinks that it will take considerable time and much puffing of Elmore copper to bring about the impending revolution. So do we! There is no necessity for "a shareholder" to write himself down a fool and say we called him so. We did not say that all Elmore shareholders were fools. We do not think they are. Something depends on the companies they are in, and we are not sure whether some of them may not deserve a different appellation, which we hold in reserve.

ON THE PROTECTION OF BUILDINGS  
FROM LIGHTNING.\*

I MAY, perhaps, be permitted to state in a few words why I have chosen lightning for the subject of my paper. My reason is that considerable uncertainty is reputed to exist amongst architects, builders, engineers, and others, who are occasionally, although not professed electricians, called upon to erect lightning conductors, and particularly because I have had quite recently two cases illustrative of this suspected uncertainty brought forcibly to my notice, one of the two cases being one in which a number of persons narrowly escaped with their lives. It seemed to me, therefore, that lightning conductors offered a meet and appropriate subject for discussion by this Association.

The first case occurred in connection with this present exhibition. The electrical and lighting committee decided that both the old and new systems of protection should be illustrated practically, so the chimney of the boiler house was ordered to be protected by a stranded copper rope of the ordinary type, and the minarets of the main building by iron wire, according to a design kindly furnished by Dr. Oliver Lodge. The erection of the chimney proceeded with unexpected celerity, and when the committee went to specify the precautions they wished to have observed in earthing the conductor, they were informed that the conductor was up, earthed and finished. The builder assured them that it was "all right;" but, appreciating the ridiculous figure that would be cut by an electrical committee were a chimney under their special care struck and injured, it was resolved to do violence to the builder's feelings, and dig up his earth. It was found that the end of the conductor was only a few inches below the surface, and was loosely embedded in builder's *débris*. That was the first case, and was detected and remedied in time. The second was only revealed by an actual visitation of lightning.

Last month, during a severe thunderstorm, and while it was raining very heavily, the inmates of a gentleman's house were startled by a tremendous report. Simultaneously a great light was seen in various rooms by different people. The house is peculiarly situated, being erected on the slope of a rocky hill, about 600 feet above the base, and some 1,000 feet below the summit. It is fitted with the electric light, all the leads being within the building. A telephonic connection exists with the stables in the valley below, some 1,000 yards distant; it consists of two copper wires thickly insulated with gutta-percha, which are used as a metallic circuit. They are underground the whole way, being laid in a wooden box buried in a trench, except at one point, where they cross a stream in an iron pipe laid in its bed. Within the house and stables the wires are led to the instruments in wooden boxing.

When the flash occurred light was seen in almost every room of the house. A tailor employed in one of them asserts that light played about his thimble and scissors, and the cook is positive that a flame appeared around her kitchen grate. The housekeeper, who was seated in her room, says she heard a faint rustling sound in the direction of one of the electric lamps. She turned her head, and was immediately conscious of a blaze of light which seemed to dart from the lamp to the grate. The next thing she remembers was finding herself on the floor, unhurt, but greatly terrified. She picked herself up and, strange to relate, made her way to a mirror, but for some minutes was unable to distinguish her reflection in it. The lady of the house saw, or believes she saw, a ball of fire, of a deep red colour, in the dining room, but others present were aware only of a dazzling light of no defined shape, which appeared to some of them to play for an instant over the wall paper, which is embossed with metal.

At the stables end a groom states that a ball of fire, this time of a white colour, about the size of a cricket ball, appeared in the middle of the room and instantly exploded with a report that stupified and deafened him, and the effects of which he felt in his ears for several days. The light from the exploded ball seemed to diffuse itself in all directions, but he was conscious of a more intense action in the neighbourhood of the telephone.

An examination showed that the safety fuses of the electric light system were melted. The hinged door of the box containing them, which was situated about 4 feet from the telephone on the same wall, was knocked off and thrown to a distance. It was much scorched inside. The telephone wires were fused in three different places, once in the iron pipe in the bed of the stream, once midway between the stream and the stables, and once a few yards on the house side of the stream. At the second place the wooden boxing was completely destroyed for about 6 inches; at the third its bottom only was knocked out. In the stables the boxing was blown off the wall, but the wires escaped injury, as did the telephones at both ends. Where fused the wires presented a sharpened or pointed appearance on the sections furthest from the house and a rounded shape on those nearest it. In the stables, not far from the telephone, some wires, apparently connected to the earth, extended partly up the wall. They are said to have been used in connection with an A B C telegraph instrument which was formerly installed there.

At the moment of the discharge—as nearly as can be ascertained—in the house, two bullocks grazing in the fields two or three miles off were struck dead. This is a most interesting fact, for it tends to substantiate what has often been asserted and sought to be established by evidence such as this, that lightning discharges frequently, if not invariably, are double; that at the moment a flash takes place from clouds to earth at one place another ascends from earth to clouds at another, a phenomenon to which the name of back or return stroke has been given. It is indeed necessary that something of the kind should happen if the comparison between lightning and Leyden jar phenomena and ordinary electricity generally is to hold good, for a circuit of some kind is a necessity. A vivid flash between clouds and earth at one point only argues a circuit completed elsewhere—that is to say, a good conducting region—an absence of a dielectric, between earth and clouds at another, just as the arc of an electric lamp signifies that there is a conducting circuit, invisible and lengthy perhaps, but still a circuit, connecting the carbons between which it plays. Such a condition may exist during rain to an extent sufficient to permit of invisible conduction over a considerable area, or an actual waterspout such as is common in the tropics may form the conducting link, leaving forcible rupture of the dielectric to take place at one point only. Absence of such a conducting region necessarily means two dielectrics, two ruptures, and two vivid and co-existent, although perhaps, and probably, widely separated flashes, stroke and back stroke. It is reasonable to suppose that lightning, at least sometimes, may be merely a neutralisation by means of the clouds of opposite tensions existing at different points of the earth's surface. As soon as the cloud is long enough to cover both points, and low enough for the tensions to overcome the resistance of the intervening air, the neutralisation takes place, the cloud simply acting the part of the discharging tongs between the knob and outer coating of a Leyden jar. Lightning usually occurs after a spell of sultry weather when there is an absence of moisture, and consequently of conductivity in the atmosphere. In damp weather the necessary neutralisation between different parts of the earth's surface takes place—according to this hypothesis—constantly and silently, for there is no longer a dielectric resistant enough to prevent it.

It proved that the house, an extensive one, is largely roofed with lead, and has several iron spires which, at their lower extremities, are in contact with the lead of

\* Paper read at the Edinburgh International Exhibition, September 5th, 1890, before the East of Scotland Engineering Association, by A. R. Bennett, Vice-President.

the roof. The highest spire was found, after the storm, to be bulged and blackened at the junction of the iron with the lead. There are numerous metal rhones or drainpipes down the walls for carrying off the rain water. These are in contact with the lead-work of the roof above, but no provision is made for earthing them below—in fact, they are built into brick drains. When I add that there is no lightning conductor, and that the house is built on a thin layer of soil covering rock, it will be seen that—the existence of the telephone wires being taken into account—all the elements necessary for a first-class catastrophe were present. The absence of a conductor was accounted for by saying that when the house was built the architect stated that one was unnecessary. The proprietor was especially desirous of knowing how the electric light and telephone wires, which were wholly under cover and cased in, came to be struck. The explanation is not difficult. As is well understood, lightning is a discharge between two areas (these areas corresponding to the coatings of a Leyden jar) highly charged by electricity of the opposite signs. The clouds usually form one of these areas, and a high or prominent object on the earth the other. The principal path of a discharge is always that of the least resistance, or best conductivity, although partial discharges may likewise occur simultaneously by less perfect routes, and the discharge takes place as soon as the accumulated tension is high enough to overcome the resistance between the areas. A high point on the earth's surface is generally selected by the lightning, because whatsoever its nature it is usually, owing to the presence of moisture on its surface or in its pores, a better conductor than the air surrounding it. If it is a perfect conductor, or supports a perfect conductor of sufficient capacity in connection with the earth and with all adjacent metallic masses, the discharge passes from its extremity to its base without developing any noticeable phenomena; at any rate, nothing which is likely to cause danger to life or property, although it has been asserted that in the case of a very violent flash side discharges from the conductor of dangerous moment occur, in spite of the best earth connection. This, however, has been inferred rather from laboratory experiments than actually proved. If the precautions which I shall endeavour to prescribe and impress upon you as necessary are faithfully followed, such side discharges, should they happen, would probably be of inconsequence. A flash may very likely leap from the conductor to neighbouring masses of metal, if these are connected to earth and not to the conductor, especially if the earth of the conductor itself is a poor one; but so leaving them without a metallic link to the conductor would be a trifling with experience. On the other hand, if one or more sections of bad conductivity intervene between the summit and the earth, the discharge, although it will pass, will no longer do so harmlessly, but will develop explosive violence at the badly-conducting gaps. Its general course will still be the path of least resistance, but it may fly to and traverse any metal that lies in anything like a direct line between the summit and the earth, even if that metal only offers a path of a few feet. This tendency to leave the conductor will be increased proportionally as the earth connection is imperfect, a fact that will account, in the case under consideration, for the lightning striking the electric light wires; they, although covered and unconnected with the earth, offered the path of least resistance for a portion of the distance, and formed a connecting link between the point at which the lightning entered the dwelling and the point at which it left.

The enquiry seemed to indicate a discharge from the valley to the clouds *via* the telephone wires, electric light leads, chimneys and spires, the intervening air spaces within the house being jumped. The lightning, on this assumption, entered the wires at the stables by leaping from the old telegraph earth to the telephone terminals, and by piercing the insulation at and on each side of the stream. Arriving at the house, it jumped from the telephone terminals to the box containing the

electric light fuses, and thence travelled by the leads into every room in the house. There it jumped to grates, pipes, and other metallic masses, and so to the metal of the roof, and away. A noteworthy point, and one which is replete with instruction to electricians is, that had the house not possessed telephonic connection with the valley it might, owing to its position on a badly conducting rock, have escaped altogether; and had it not had electric light and bell leads in every room it still might have escaped in spite of the telephone wires. On the other hand, had not such a golden bridge as was offered by the leads existed, a leap from the basement to the roof through the body of the house might have been attended by utterly disastrous consequences. But the accident does not teach that we should deny ourselves the advantages attendant on telephones and electric lights. It teaches rather that these conveniences may be a source of danger if inconsiderately and carelessly fitted, just as gas or stoves or lamps may become centres of danger if ignorantly or recklessly dealt with. When telephone wires, and especially metallic circuits, are taken into a building they should be fitted as near the point of entry as possible with a good lightning discharge. This necessity I recognised several years ago as a consequence of more than one accident, since when all metallic circuits constructed by the National Telephone Company have been so fitted. Such a discharger costing only a few pence, would in all probability have shunted the lightning to earth, and the inmates of the house might not have even been aware that a discharge had taken place. Telephones working with an earth return do not require such care as metallic circuits.

A discharge of lightning through a conductor may be roughly illustrated by hydraulic analogy. Let us suppose a long perpendicular pipe with a number of lateral holes at intervals, its bottom extremity opening into a large empty cavity. A mass of water caused to fall suddenly into its upper end would descend through the pipe into the cavity, and having no resistance but the friction of the pipe and the resistance of the air in the pipe to overcome, it would so fall without any, or but little, of the water escaping through the lateral holes. This answers to a lightning conductor of sufficient capacity having a good earth. A pipe of small diameter opening into a large cavity would represent a conductor of insufficient capacity though with a good earth. Through this thin pipe the water could only flow comparatively slowly, and the tendency to leakage through the lateral holes would be considerably increased.

Now, imagine a large pipe with an obstacle placed at its bottom so that the diameter is reduced one-half, or a large pipe opening into a cavity incapable of containing the water let down; then the water descending with a tremendous impact is partially stopped by the obstacle, or by the filling up of the cavity. The water will rebound and spurt violently out of the lateral holes. This corresponds to a conductor of sufficient capacity connected to an insufficient earth, and the effects will be exaggerated proportionally as the aperture at the bottom is reduced. If the same pipe is taken with the bottom end plugged up, the stoppage and spurting of the water will be greatly augmented, and perhaps the pipe will burst from the suddenly exerted lateral pressure. This answers to a conductor with a very imperfect earth. The analogy is striking here; the water, like the electricity, is seeking earth, its lowest level, but failing to find it through the pipe, spurts or bursts out laterally, and then recommences its descent by the nearest channel it can find. The water may have to turn corners and run down flights of stairs on the way, so the electricity may have to avail itself of anything conducting whether it lies directly in the path or not.

I now propose to detail the recommendations I have made with the view of preventing a recurrence of the accident at this particular house. The example is a peculiar one in more than one respect, but still the recommendations embody the precautions which, with variations due to local surroundings, are necessary in

every case. The main object is obviously to provide a path of small resistance between the roof and the nearest earth. Owing to the rocky foundations of the house, this would seem to be at the stream in the valley and its vicinity, as the unusual mercy of a pioneer flash has clearly enough indicated.

The leaden roof with its spires which rise above everything may be left as it is, but seeing that rarefied air and soot are both conductors—comparatively poor ones, it is true, but still almost infinitely superior to air at the normal pressure—and that there are something like 40 chimneys opening above the roof, it is obvious that, taken collectively, the chimneys, especially when fires are on, present a conducting surface of very large area, and consequently of low resistance between the interior of the house and the atmosphere above it. When fires are burning this conducting surface may extend, in the shape of a column of rarefied air, considerably above the highest spire. To prevent the electricity selecting this conducting path of chimneys in parallel a better one must be provided, and this can fortunately be accomplished, as pointed out by Dr. Lodge, by erecting a skeleton cage of wire provided with a few pointed upright pieces above each group of vents, so that it may be enveloped by the rarefied air ascending therefrom. Each cage should have a soldered connection to the leaden roof, or by means of an iron wire direct to one of the conductors. These conductors may consist of at least four, preferably more, galvanised iron wires, No. 4 B.W.G., carried from soldered connections with the metal of the roof to the ground at as many different parts of the house, say at each corner, and at convenient intermediate points, and thence continued without break of continuity, and buried without boxing in a trench dug close to the boxing containing the telephone wires as far as the stream in the valley. The stables should be similarly treated, all the metal ridges of the roof, gutters, &c., being joined together by wire, at least one point projecting above everything else, and thence by means of two No. 4 wires laid in a trench also as far as the stream. There the water should be temporarily dammed back or diverted, and a hole excavated in the bed of the stream some 3 feet deep by 3 feet square. Into the hole a few bushels of retort carbon from a gasworks should be rammed; some 12 feet of each of the six iron wires—four from the house and two from the stables—should be coiled upon the carbon, then some more carbon well rammed down. Finally, the hole should be filled by well-rammed soil (not rock), and the water allowed to flow over it. If inconvenient to dam or divert the stream, the hole may be dug at one side of the water, and the water admitted over it when completed. There will then exist from the highest point of the house to the highest point of the stables a conductor making good earth at one place at least, and as good as the nature of the soil will permit at all others along the route, which is approximately that of the telephone wires. In the presence of such an arrangement, there would be no inducement for electricity to jump through several feet of air, and pierce thick gutta-percha insulation to invade the telephone wires. Further, in the house all systems of pipes or other masses of metal, such as grates, boilers, &c., should have connections with at least one of the conductors. Such connections may be of No. 5 B.W.G. galvanised iron wire, and should be soldered wherever possible. Of course, neither the electric light nor the electric bell nor the telephone wires can be so connected without interfering with their proper functions. This is a little unfortunate, but they may be dealt with by encasing a couple of feet of each of them in metal pipes, with India-rubber or porcelain rings between the leads and pipe, so as to make actual metallic contact impossible, while, at the same time, providing the shortest possible path for lightning between the three sets of leads. This would be attained by connecting the three lengths of pipe together and to the conductors by means of a No. 5 galvanised iron wire, soldered. In addition, the telephone wires should be fitted with an ordinary discharged at their place of entry. The object of these

branch connections is, of course, to prevent any jumping in the house, whatever may happen in the future. If the main earth connection became insufficient from any cause, the lightning would again make for the stream *via* the telephone wires; but if all metallic masses in the house, and the light and telephone wires, are treated as described, it would do so without any dangerous discharge. The only jump would be across the air space between the tubes and leads inside them and through the insulation, and this would be entirely harmless.

I recommend iron wire because—for the theoretical reasons adduced by Prof. Hughes and Dr. Oliver Lodge, into which I have no time to-day to enter, and with which many of you are no doubt perfectly familiar—iron is now widely admitted to be as effective as copper for currents appertaining to the character of lightning, and because iron has been employed habitually in America, in France, and elsewhere for a long period, and there is no evidence forthcoming to show that the percentage of accidents in those countries has been greater than in Great Britain, which has hitherto adhered rigorously to copper. True, some authorities still advocate the use of copper, but the greater cost of that metal precludes its employment so liberally about a building as could be wished, and when the greatest use has to be made of a certain sum, I consider, theoretical reasons apart, that it is beyond comparison wiser to invest that sum in six or eight iron conductors than in one or two copper ones. Copper would be preferable, on account of its greater durability when buried, but still galvanised iron will endure for years when so treated. Theoretically, a conductor of flat section like hoop iron would be better than wire, but it is more liable to decay. In addition to such conductors as described being fitted, the existing drain pipes should be connected to the roof by soldered wires or bands, and connected at the lower extremities to the conductors by a No. 5 galvanised iron wire, carried round and soldered to each of them; and a flagstaff standing about 20 yards from the house should have an iron wire run up it and connected to the conductors. In fixing the cables, sudden bends or changes of direction should be avoided. If all these precautions are taken, and the connections are examined from time to time, and repaired when necessary, the chances of another visitation from lightning will be very remote.

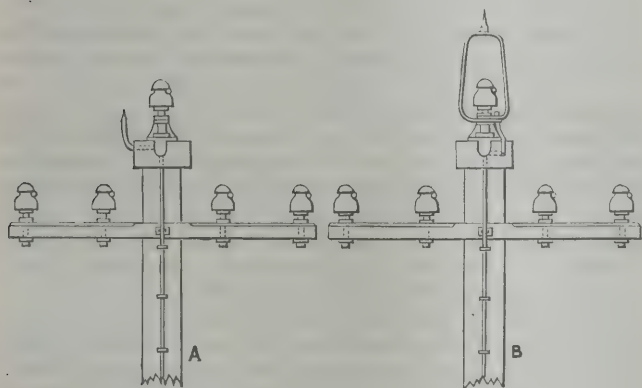
As before remarked, the recommendations are designed for a special case, and would not be applicable in all their details to many others. Still, to secure immunity from lightning, certain invariable precautions have to be taken in all cases. These are specially, firstly, having at least one metal point—multiple points are much better—in as perfect connection with the earth as possible, preferably by several paths, raised above all stone, wood, and other non-conducting portions of the building. These points should be preferably over or quite close to the chimneys, unless wire cages are provided specially for them. Secondly, connecting all pipes, grates, bell wires and other masses of metal in the house to the conductors, preferably by means of soldered connections; when this cannot be managed, as with light and telephone leads, then by providing a small air space across which the discharge may jump harmlessly. Thirdly, by securing a good earth. When a house is built on rock, or on a thin stratum of soil over rock, or on chalk, this point requires special attention and study. Where gas and water pipes exist, they should be joined to the conductors both above and below ground, and gas and water meters should be bridged by soldered No. 5 wire. Even when water pipes exist Dr. Lodge considers it better to provide a separate earth for the conductor, also attaching it to the pipes, but this is a refinement I have not myself adopted when good water mains, always full, and jointed with lead, have been at hand.

These are the three important points to keep in view in designing protective systems for buildings, and the architect or engineer should see personally that his design is carried out. If such precautions were general, we should hear less of mysterious fires than we do.

One thing has been brought out over and over again in connection with lightning conductors. Ordinary workmen are quite untrustworthy, and require constant supervision.

In conclusion, I am able to show you some effects of a recent lightning storm, which emphasise the necessity of having the highest point of any structure earthed. Last month a telephone wire erected on the tops of poles between Murtle and Cults, in Aberdeenshire, was struck. The wire was out of use, and was insulated at both ends, so that the lightning found no vent at the extremities. It accordingly struck through the solid porcelain insulators to the iron bolts supporting them, and jumped thence to the earth wire, which was stapled up the poles to within an inch or two of the bolts. It shattered the insulators on the 1st, 2nd, 7th, 15th and 35th poles, counting from Murtle. At three of the poles the wire, No. 18 B.W.G. silicium bronze, was fused, and at the foot of one pole the earth was distributed and the grass burnt. Three of the insulators with fragments are on the table before you; the others were reduced entirely to small pieces, many of which could not be found. On one of those before you a metallic deposit from the fused wire is distinctly visible. Had each pole carried an earthed point raised above the topmost wire, the discharge would, almost to a certainty, have neglected the path of far higher resistance through the wire and porcelain, and all damage would have been avoided.

This is a weak point in our telegraphic practice, common to post office, railway, and telephone companies, and one which I have raised my voice against for a good many years past. In the figure, A shows



the ordinary method of terminating the earth wire, which leaves the topmast line unprotected, and B the method I have adopted with the object of shielding it.

In house practice the analogy to the short earth wire is a system of gas or water pipes, bell or other wires, extending up to, say, the attics, with a non-conducting structure of plaster, wood, and slates intervening between the highest point touched by the metal and the air of the house. This non-conducting stratum absolutely does not exist when lightning is in question, and in the event of a discharge occurring between the metal in the house and the clouds above, would be shattered and scattered just as you see these insulators have been. It is a curious question what the precise nature of the force is that splits porcelain in the manner shown. The destruction of trees and telegraph poles by lightning has been attributed to the sudden generation of steam in the pores of the wood, due to the heat of the discharge or to expansion by the heat of the air which the wood contains; but in porcelain there is neither moisture nor air; yet, as you see, when it chances to intervene in the path of the least resistance, that does not prevent it from being split up and utterly destroyed.

**Lighting at Southampton.**—Messrs. Crompton & Co. are erecting the central station of the Southampton Electric Light and Power Company, Limited. Current will be charged for by meter.

## UPON THE PERFORMANCE OF SIMILAR SYSTEMS OF DIFFERENT DIMENSIONS.

By W. MOON.

IN studying the different effects produced by similar systems of different dimensions, it is sometimes convenient to speak of the system being increased in all its dimensions  $D$  times and producing an effect of  $D^n$  times.

Thus the gravitational force between two bodies is proportional to the product of their masses directly, and to the square of their distance apart inversely, and, therefore, if the two bodies and their distance apart is uniformly increased  $D$  times, then the force between them will be increased

$$\frac{D^3 \times D^3}{D^2} = D^4 \text{ times.}$$

In a similar manner take two magnets that are small as compared with their distance apart, then the deflective force of the one upon the other will be proportional to their masses directly and inversely as the cube of their distance apart, and, therefore, with several such systems the deflective force exerted by each is proportional to

$$\frac{D^3 \times D^3}{D^3} = D^3,$$

provided, of course, that all the systems have the same magnetic intensity.

The force between two electrically charged bodies  $= \frac{q \times q_1}{d^2}$ , so that in similar systems of different dimensions charged to the same surface density the force is proportional to

$$\frac{D^2 \times D^2}{D^2} = D^2.$$

The distribution of the charge over the bodies would remain uniform only when the surface density was constant, whatever the dimensions. That is when the potential of the charge varied as the dimensions.

The gravitational force of a body at a point when the body together with the distance of the point are uniformly increased  $D$  times is proportional to  $D$ .

The intensity of field produced by magnets of different sizes, but of the same intensity of magnetism, is constant at similar points whose distances from the magnets is proportional to their dimensions.

Similarly the electric force of charged bodies upon points at distances proportional to the dimensions of the body is the same when the bodies are charged to the same surface density.

The kinetic energy generated by gravity in forming a body, or system of bodies, by bringing up the particles of matter from infinite distance would be proportional to  $D^5$ .

The potential energy of bodies charged to constant surface density is proportional to  $D^3$ , that is, it is equal to half the product of the potential and the charge  $= \frac{D \times D^2}{2}$ .

The energy expended in magnetising a permanent magnet is also proportional to  $D^3$ .

The difference between these three effects is interesting.

While kinetic energy is generated in bringing together the particles of a body by gravity, on the other hand, potential energy is created in giving a body a static charge of electricity, and in the case of a permanent magnet energy is expended in its magnetisation which is not again recoverable. In the last case the energy expended is proportional to  $\frac{I^2}{2} K$  where "I" is

the intensity of magnetisation and "K" the coefficient of susceptibility.

However, in the case of a temporary magnet the energy is recoverable and is proportional to

$$\frac{1}{4} \frac{H^2}{\pi} + \frac{1}{2} K = \frac{1}{8} \frac{1}{\pi} \text{ H.B.}$$

per unit of mass.

Although the size of the field produced by a magnet is proportional to the magnet's size or  $D^3$ , yet the portative force is proportional only to the area or  $D^2$ . This is natural since the strength of materials is proportional also to  $D^2$ , and, like the strength of magnetism, is limited also by a coefficient.

The strain of torsion that any material will bear is proportional to  $D^2$ , or to the area when the leverage increases as  $D$ .

Therefore it follows, that with either belting or shafting the power transmitted with constant linear velocity is proportional to  $D^3$  or to mass<sup>3</sup> if the length of the shafting increases as its dimensions.

In a similar manner power can only be transmitted by a current of electricity in proportion to the area of the conductor when the fall of potential per unit length is the same and the current is proportional to the sectional area of the conductor. But when the heat generated by the current is taken into consideration, the transmission of power by electricity is at a disadvantage as compared with other means, since for a conductor heated to constant temperature the power transmitted is proportional only to  $D^3$  when the fall of potential per unit of length is constant, and it is necessary to make the fall of potential per-unit-length equal to  $D^{\frac{1}{2}}$  before the power transmitted is proportional to  $D^2$ .

If the amount of heating of the coils of electro-magnets, whose cores are similar in shape but of different sizes, is the same, then for the same induction through the cores the amount of copper upon the cores is proportional only to  $D^2$ , while, of course, the weight of the cores is proportional to  $D^3$ . The rate of expenditure of energy in the coil is also proportional to  $D^2$ , that is to the surface.

If, however, the depth of the coils upon the cores is proportional to  $D$ , instead of being the same depth upon the different cores, then the rate of expenditure of energy in the different coils would be proportional only to  $D$ . Of course the former of these methods should be used if it is desired to make the amount of copper used a minimum. But if it is required to have the resistance of the coil or the rate of expenditure of energy therein a minimum, then the latter method of having the amount of copper proportionate to the iron should be used.

If both the conductor and the iron of an armature of a dynamo vary uniformly as the dimensions; then when the conductor in each case has the same linear velocity, the E.M.F. generated will be proportional to

$D$ , and the resistance of the conductor to  $\frac{1}{D}$  and if the

external resistance also varies as  $\frac{1}{D}$ , the current generated would be proportional to  $D^2$  and the heat given off in the armature and the work performed would be proportional to  $D^3$ . But the radiating surface of the armature is proportional only to  $D^2$ , and it is not therefore possible for a dynamo to have an output proportional to its mass if its heating is considered.

Again, since it is generally necessary to have the different dynamos give the same E.M.F., then the resistance in each case will be proportional to  $\frac{1}{D^3}$  and if

now the current is made proportional to  $D^{\frac{1}{2}}$  that is to (sectional area of conductor)<sup>3</sup> then the heating of the armature will be proportional to  $D^2$  or to the radiating surface, while the output would be proportional to  $D^{\frac{1}{2}}$ .

The output of dynamos, then, as a general rule will be proportional to  $D^{\frac{1}{2}}$ . And since the dynamo and electro-motor are reversible it follows that the work an electro-motor will perform is also proportional to  $D^{\frac{1}{2}}$ .

In the alternating dynamo the power required to maintain the magnetism of the field magnets would of course be the same power of the dimensions as in the direct dynamo. If the amount of iron

and copper on the armature coils both increased as  $D^3$  while the linear velocity of the machine was constant; then the E.M.F. would be proportional to the area of the armature coils to the angular velocity, and to the number of turns on the

armature coils =  $\frac{D^2}{D} = D$  if the number of turns is

constant, or =  $\frac{D^2}{D \times D} = 1$  if the length of wire on

the armature coils is constant. Now, if the current in the first case is regulated to  $D^{\frac{1}{2}}$ , or in the second case to  $D^{\frac{1}{2}}$ , then in each case the rate of heating of the armature coils would be proportional to  $D^2$ , and the output of the machine to  $D^{\frac{1}{2}}$ .

Of course the size of a dynamo of a particular type and having a constant electromotive force and magnetic induction is limited by the fact that the conductors of the armature ultimately become as few as the bars of the commutator. Again, for electric lighting purposes the time of an alternation of current must not be greater than a certain amount, for this reason large alternating dynamos are constructed of a number of small coils instead of a few large ones. If it were possible to give large alternating dynamos the same angular velocity as to smaller ones, it would not of course be necessary to thus multiply the number of coils, but this is mechanically impossible since the centrifugal force would then be proportional to  $D^4$ , while the strength of materials resisting this force would be only proportional to  $D^2$ .

It is interesting to compare the performance of dynamos with that of the steam engine.

Thus suppose a boiler and its steam engine to be uniformly increased in all their dimensions whilst all the linear velocities are kept constant. As the draft is of a constant velocity the amount of fuel consumed in the furnace is proportional to the area of the grate, that is to  $D^2$ , and therefore the rate at which steam is generated is proportional also to  $D^2$ . The steam being at constant pressure, the thickness of the boiler plate and the strain upon it would be proportional to  $D$ , since the strain would be proportional to the circumference of the boiler. In like manner the thickness of the pipes and of the cylinder of the engine would vary as  $D$ , and be in proportion to the strain upon them. And since the pressure upon the piston rod of the engine is proportional to its area or to  $D^2$ , therefore the strain upon the piston, its connecting rods and shafting, belting, &c., would be proportional to their strength. Now, the piston having constant linear velocity the rate of performing work would be proportional to  $D^2$  or (mass)<sup>3</sup> or (size)<sup>3</sup>.

If, however, the linear velocity could be made proportional to  $D$ , that is, if the angular velocity and the time of a period of the engine is constant, the work the engine would perform would be proportional to  $D^3$ .

But just as the pressure of the steam is limited by the strength of the material of the boiler, so the linear velocity of the piston is ultimately limited by the velocity of the steam, so that it is only within very narrow limits that the power of a steam engine can be made proportional to its mass.

Also, as with the dynamo, so with the steam engine, the centrifugal force and the strain due to change of momentum with constant linear velocity is proportional,  $D^2$ , that is proportional to the strength of the materials to resist the strain. But with constant angular velocity, these forces would be proportional to  $D^4$ .

The capacity of similar boilers of different sizes is proportional to  $D^3$ , while the rate at which the fuel is consumed is proportional to  $D^2$ , therefore, the time of getting up steam is proportional to  $D$ . Also, since the mass of the moving parts of a steam engine is proportional to  $D^3$ , while the accelerative force of the pressure of the steam upon the piston is proportional to  $D^2$ , therefore, the time of starting the engine is proportional to  $D$ . The same, of course, applies to the time of starting a dynamo or any motor.

In similar electro-magnets of different sizes, the time of acquiring its magnetism, or its time constant, is pro-

portional to its dimensions, since its electro-magnetic inertia is proportionate to  $D^3$ , while the force accelerating the magnetism of the electro-magnet is proportional to  $D^2$ .

### THE TELEPHONE IN AMERICA.

THE development of telephonic enterprise in the United States presents many interesting features, and not the least worthy of consideration is the important position in business and domestic relations occupied by this method of communication. The promptitude with which our American cousins grasped the full meaning of the advantages and possibilities presented by the telephone, and the rapid and enormous extension of telephonic systems throughout the States, stand out in strong contrast with the slow and hesitating procedure of European countries. The electric telegraph is credited with having completely changed the methods of conducting business formerly in vogue; the telephone is responsible for a no less thorough revolution in the mode of intercourse—social, domestic, and commercial, as conducted in towns and cities.

The history of the telephone in America is practically the same as that of the American Bell Telephone Company, of Boston, and a brief account of the operations of this association may be of interest to those of our readers who have not made a special study of the matter.

The telephone was brought into a practical shape by Graham Bell in 1876, and the original patent, and all subsequent ones, both as regards the telephone and the microphone, were acquired by the American Bell Telephone Company, who thus became almost the exclusive possessors of all telephonic and microphonic appliances and installations in America.

Up to the year 1887, the company worked its patents by leasing the right of using the telephone to various associations, under certain conditions, and over defined areas. These companies paid an annual tariff of \$20 per instrument (including receiver and transmitter) hired, in addition to a charge of 25 per cent. of their receipts for the use of conduits.

The earlier concessions granted to the working companies were limited to a period of five years, and were then renewed only on new conditions. The concessionaire companies were obliged to place in the hands of the Bell Telephone Company 25 per cent. of their share capital, and at the same time were granted a reduction of 40 per cent. on the annual charge for hire of instruments. The working companies founded under these conditions have entered the third renewal of contract, so that the Bell Telephone Company is at present owner of more than half of the capital invested in telephonic enterprise in the United States.

In 1887 the Bell Company took another step in the direction of securing monopoly, by founding the American Telegraph and Telephone Company (the Long Distance Telephone Company), which undertook, with the capital of the parent association, the establishment and working of telephone lines connecting the largest towns to one another. The present system of this company embraces all the important towns from Buffalo to Washington, and the lines are being extended westward to Chicago, and in the south-west between Philadelphia and the Pennsylvania coal and oil districts.

The original patent acquired by the Bell Company expires in 1893, and in order to make competition as difficult as possible, the company has bought up all patents which are considered likely to be of practical utility. The company has also become the principal shareholder in the Electrical Subway Company of New York, and since new companies encounter great difficulty in obtaining the necessary authorisations for laying down their conduits, competition in this direction is not to be much dreaded. We may here mention that the annual charge for the use of these conduits is

fixed at \$850 per mile for a telephone cable containing 50 double conductors.

The Bell Telephone Company, in its report for the year ending December, 1888, gave the number of offices under its control as 742, in addition to 452 branch offices, the length of lines as 170,471 miles, of which 17,038 miles are underground, the number of instruments leased out as 411,511, and the number of subscribers 171,454 (now considerably over 200,000).

The overhead lines in America, whether for electric lighting, telegraphy, or telephony, generally leave much to be desired with regard to construction and maintenance. The lines of the Long Distance Telephone Company set, however, a good example in these respects, their wires being the only ones which withstood the terrible snowstorm of March 12th, 1888. Their lines have a total length of 1,491 miles, with 39,776 miles of conductors. The wires are of drawn copper 3 mm. in diameter; the posts average 40 to the mile. Among the more important lines are those between Buffalo and Rochester, 69 miles; Buffalo and Syracuse, 99 miles; Buffalo and New York, 497 miles; New York and Boston, 253 miles.

As an example of the insulation of these lines we learn that tests taken on the New York and Boston line, 253 miles in length and having 120 conductors, gave an average insulation resistance of 208 megohms per mile of conductor.

### ON MAGNETIC CIRCUITS.

By H. E. J. G. DU BOIS.\*

A CONSIDERABLE extension of our knowledge of magnetic induction has lately taken place. This, like many other additions to the realm of science, was chiefly called for in order to meet the wants of designers of electric machinery; and it has accordingly been arrived at in an essentially practical way. The aim of this preliminary communication is to show how physical science may draw advantage from some of these results, and may obtain them by unobjectionable purely physical methods. In doing so I shall not so much use the conception of lines of force, but shall rather start from the consideration of magnetisation. For it is the latter quantity, which for experimental reasons (*Phil. Mag.* [5] xxix. p. 303, 1890) I believe must be taken as the fundamental one from the physical standpoint, much more so than induction, to which such importance has lately been attached.

The idea of an analogy (even when only in mathematical treatment) of magnetic systems with other systems of fluxes (hydrokinetic, thermal, electric) dates back as far as Euler. Faraday (and following him Maxwell) and Sir W. Thomson then each developed it in his own way. It has been worked out and practically applied, however, during the last decennium.

Bosanquet (1883), Rowland (1884), W. v. Siemens (1884), Gisbert Kapp (1885), especially consider the analogy with the flow of electricity, and accordingly apply Ohm's law to magnetic circuits. As, however, this law essentially implies the resistance being constant, independent of the current flowing, the above extension of its most characteristic meaning can hardly be conceded from the physical point of view; nothing is thereby meant to be said against certain practical advantages gained by introducing an (essentially variable) magnetic resistance. Quite lately, again, Pisati (1890) has laid much stress upon the analogy with thermal circuits, and accordingly has applied Fourier's law to certain magnetic systems. This appears perhaps less objectionable in so far as thermal conductivity is not necessarily a constant as its electric analogue is, though Fourier originally introduced the former as such. But

\* Translation communicated by the Author to the *Phil. Mag.* for October, 1898, being the abstract of a paper read before the Physik. Gesellschaft, Berlin, June 27th, 1890.

even then it depends upon temperature, not upon its space-variation or upon the flow of heat: the analogy is therefore in no case a complete one, magnetic conductivity being of course independent of magnetic potential.

No physical objection, however, appears to exist to the totally different treatment the question received at the hands of J. and E. Hopkinson (1886): they started from two safely established mathematical propositions, and only made some auxiliary assumptions in order to simplify the (approximate) calculations. In this way they so arrived at their graphic construction, now used to a certain extent in machine design, and which will be reverted to below.

Poisson's old theory of magnetic induction, extended by Neumann and Sir W. Thomson, as laid down *e.g.* in Maxwell's treatise, is known to rest on the fundamental assumption of constant susceptibility; it therefore applies to all substances except "ferromagnetics" (iron, cobalt, nickel, magnetite, and any substance which may yet be found to behave similarly). Kirchhoff then introduced a new theory (in 1853) by making the more general assumption that magnetisation is a function (capable of experimental determination) of the total magnetic intensity. Besides the important solutions of certain particular cases (ellipsoid, closed ring), he restricted himself to giving a few integral equations in the place of Poisson's. However, these were of but little practical use, and are hardly more so now that Duhem has lately taken up the analytical problem anew.

A more geometrical treatment of the new theory showed the distributions of the vectors concerned to be as follows:—(a) magnetic intensity: lamellar; (b) magnetisation: complex-lamellar; (c) induction: solenoidal; (d) also the three vectors are easily seen to have the same direction at every point. The proof and further discussion of these propositions cannot be given here. It may be remarked that homogeneous, isotropic ferromagnetic substance is assumed, through which no electric currents are supposed to flow; neither is hysteresis taken into account.

The simple type of a circuit not completely closed is a thin ring containing a radial air gap and subjected to a uniform tangential magnetising force. This particular case, a solution of which has to my knowledge never been attempted, is reducible to the known case of an ellipsoid of revolution. In fact, it is only necessary that the "self-demagnetising factor" be capable of calculation; *i.e.*, the number into which the magnetisation has to be multiplied in order to obtain the intensity of the self-demagnetising effect. Let this numerical factor be, as usual, denoted by  $N$ ; for sufficiently long ovoids (prolate ellipsoids of revolution) of axial ratio,  $m$ , it is found by the well-known equation

$$N = \frac{4\pi}{m^2} (\log_e 2m - 1).$$

Now let the gap of our ring have the angular value  $\alpha$ ; *i.e.*, an arbitrary concentric circle in it being considered, the  $\alpha/360$  part of this will lie in air, the  $(360 - \alpha)/360$  part in the ferromagnetic substance. A consideration of the line integral of the self-demagnetising intensity, which must vanish along any such closed circular line of integration, leads as a first approximation to the result that

$$N = \frac{4\pi\alpha}{360 - \alpha} [\text{approx. } \div 0.35\alpha].$$

The proof cannot well be given without a diagram. Both particular cases are now comparable in every respect, as the following short table shows:—

Ovoid.	Factor.	Ring.
$m$ .	$N$ .	$\alpha$
20	0.048	2.41
30	0.032	1.22
40	0.026	.76
50	0.018	.52
100	0.0054	.15
$\infty$	0	0

Now Lord Rayleigh has given a graphic construction for ovoids, which Ewing expresses in the following words:—From the ordinary curve of magnetisation for infinitely long ovoids, that corresponding to a given finite one may be obtained by shearing the diagram parallel to the axis of abscissæ through an angle, which is simply determined by  $N$ , therefore also by the given ratio of axes. By the above the curve for closed rings may now, in the same way, be sheared into a diagram for a ring with a given angular gap.

The analogy of this process with the Hopkinsons's well-known graphic method is obvious, though at first essential differences appear to exist; *e.g.*, the quantities used for co-ordinates are not the same in both cases. However, a comparison in detail finally leads to the identification of both constructions, so that in any given particular case the curves would exactly overlap, supposing the co-ordinates to be measured to proper scales. Our problem, a solution of which was first necessitated and afterwards approximately given by machine practice, has therefore now been solved to the same order of approximation by physical methods.

The degree of this approximation, the allowable limits for thickness of ring and width of air gap, the amount of "leaking" of lines of force, &c., can only be determined by experiment on as large a scale as possible.

## STREET RAILWAY MEN IN CONVENTION.

### *Cross-examining Electricians. Revelations.*

UNDER the presidency of Mr. J. N. Partridge, the Street Railway Association of the State of New York, held its eighth annual meeting on the 16th ult., at Rochester. The President, in his address, dwelt upon the marked progress that had been made since the last meeting by the substitution of mechanical and electrical devices for the propulsion of street cars in the place of horses. This address, whilst setting forth some of the advantages of electric traction contained nothing of special interest, and it was followed by a paper "On an Electric Street Railway Motor," read by Mr. J. W. McNamara. This paper, the only one presented to the meeting, was very short, concise and to the point; it referred to the conversion of a horse car line at Albany into an electric one, by the Thomson-Houston Company. The contract was given out on the last day of November, 1889, and on May 1st, 1890, all the horses on that line were withdrawn. None of the drivers had had any training until the evening of April 27th, 1890, yet they were able to begin running schedule trips with three cars the next day. Four months' experience has taught the author that the electric motor is efficient and reliable, but he has yet to learn that it will ascend an 8 per cent. grade at the rate of 5 miles per hour in winter as it did in summer. The question as to whether the electric motor is as economical as the horse cannot yet be answered, and need not be answered—so says the author in concluding his address.

The "discussion" which followed was remarkable, for several reasons: in the first place hardly any reference was made to the paper read; secondly, the speakers, mostly representatives of contractors, referred to the advantages of their respective "systems," somewhat depreciating those of rival concerns; and, thirdly, for the cross-examination which certain electrical experts had to undergo, which revealed some interesting facts.

Mr. Frank Rogers, representing the Short Electric Railway Company, of Cleveland, stated that the "series" system has been abandoned by his company, and that they used now the parallel system, like Thomson-Houston and Sprague. Questioned by several gentlemen as to the reasons why the "series" system has been abandoned by its own inventors and former advocates, Mr. Rogers explained that it could only be worked successfully with two or three cars, but with

more than five on the line it was a failure. The trouble was, that it was difficult to manufacture a constant current generator that can be operated with little attention. "The generator fluctuates, so that it does not take care of the current." In the parallel system the electromotive force is constant. In the series system the current should be, but is not, and for that reason it is not adapted for a large number of cars. The construction of the conductor was too complicated, a switch being used in it. Prof. Short, the originator of the "series" system, had studied the question very carefully, and has spent a great deal of money in trying to work the system up and make it a success, and has also experimented largely in underground work before the new company was organised; but since then the parallel system has been adopted.

Mr. Rogers prefers the single overhead wire and rail return; it is not so complicated, and in a large city where there is one line crossing a number of tracks, it lessens the number of wires overhead. At Cincinnati they were obliged to put in the parallel double overhead wire on account of the telephones there, and the street railway managers being largely interested in the telephone companies. Many other questions of less importance were addressed to Mr. Rogers and satisfactorily answered, when Mr. E. E. Higgins, of the Sprague Company, which is now part of the Edison General Electric Company, was called upon to give his version on the subject.

Mr. Higgins claimed that the principal things brought out by Mr. Sprague, and copied ever since, were the placing of the motors underneath the cars, and attaching them to the axles on one side, and to a spring support on the other. Then the control of both motors of the car from either platform was another important point. The method of winding the Sprague motor field, says Mr. Higgins, is entirely different from all others. They are wound in three sections each; the control of speed is effected by different combinations of these coils without the use of wasteful resistances. The consequence is that the cost of coal per car is less than with any other system. Mr. Higgins does not seem to be aware that all these points, which render the Sprague system so superior, were invented and applied by Mr. A. Reckenzaun long before, as can be readily seen by Mr. Reckenzaun's patent specifications, 1882 to 1885, as well as by numerous papers read, and articles in scientific journals. The claim to the conception of the under running trolley, Mr. Higgins believes, is disputed, and presumes that it is one of those early contrivances which may have been brought out by others at the same time. It has been adopted everywhere, and is the only true way of getting at the root of the matter. Since August 1st, Mr. Edison had been devoting his entire attention to some changes in the motor. They referred merely to mechanical details. The fields of the motor are now spread slightly, so as to allow of more wire on the cores. The gears have been widened, but the most important advance which has recently been made in electrical railway work is the adoption of the new style of winding the armatures. The old armatures were wound in accordance with what is called the Siemens method; the wires at the ends of the armature are in a bunch, crossing and recrossing each other, and not being firmly fastened in place, there is necessarily some chance for the play of wires, and this results in the armatures frequently burning out. The first effect of this method is that there may be a maximum pressure wire touching a zero pressure wire, and the slight motion between these two will cause the insulation to become abraded, and a short circuit follows. In the new armatures the coils are wound separately, and there is no bunching of wires at the ends. No definite description of the winding is given; but if the "drum" armature is adhered to, we presume the ends will be arranged on a plan similar to that devised by Mr. Crompton for his dynamos.

Mr. Norman McCarty, of the Thomson-Houston Company, mentioned that his firm had long recognised the fact that the electrical railway apparatus is not so much an electrical as a mechanical problem. They use plain

series-wound field magnets, and have made up their minds that it is a good deal better to spend a little more for coal, and avoid wear and tear. This company uses the much-abused rheostat, which has the advantage that the car can be started without a jar. Regarding line construction, the Thomson-Houston Company is not limited by any patent, the method of construction varying with the conditions of the circuit. There is a patent on a system by which the line is fed at regular intervals; there is no patent on the ordinary system used.

Interrogated by Mr. Richardson, Mr. McCarty stated that he could not explain the superiority of the Thomson-Houston system over the Sprague system without criticising the latter. The Thomson-Houston cars and trucks were heavier, the motors heavier and stronger built, the gears were wider, and electrical complications were eliminated. He did not care about electrical theories so much as mechanical perfection, and that was the secret of his company's success.

Mr. Richardson asked purely for information, as he represented several tramway companies which were contemplating the purchase of electrical apparatus, and had not purchased a thing yet. He called attention to the fact that a leading Boston newspaper sent out letters asking for information from all cities in which electric railways were operated, enquiring what systems they used, whether there had been any loss of life in connection with the wires, whether there was any objection to the overhead system on the part of the public, and what had been the effect on the street railway service of the particular locality. Answers had been published, so far as received, from 64 different places, and all but four of them were favourable to electricity. Nashville, Tenn., was the only place where there was any loss of life reported, and the answer from that place was very amusing. There had been a wire broken in the city, causing the death of a horse, and a negro woman caught up the wire and threw it over, and it gave her a shock that was very funny in its effects, but did her no injury. It killed the horse, but it did not kill the woman, going to show that it is easier to kill a horse than it is to kill a human being, especially a "nigger."

Another objection came from Newport, R.I., where the "upper ten" were objecting to anything which should popularise riding.

Mr. F. R. Chinnock, in referring to complaints on the part of telephone companies, said that the simple way to prevent induction caused by electric railway wires is to provide a return metallic circuit; but suggests that the telephone people should go to this expense.

## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—LEEDS, 1890.

### SIR WILLIAM THOMSON'S NEW ELECTRICITY METER.

(Read before Section G, September 8th, 1890.)

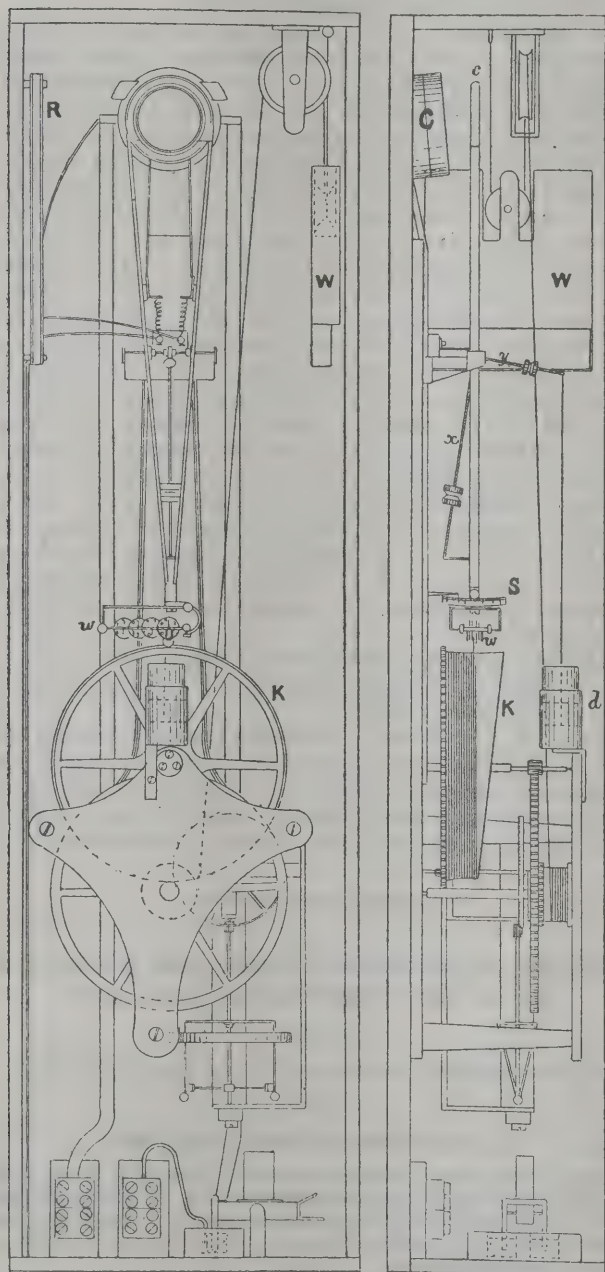
This instrument forms at once an indicator, by which the strength of current passing at any given instant can be read off on a scale, and a supply meter, by which the amount of current that has passed through the meter during any given time is recorded on a train of counting wheels.

The indicator consists of a light aluminium frame, free to turn about a horizontal axis, having at its top end a coil of fine copper wire, *c*, and at its lower extremity a train of counting wheels, *w*. The frame is supported on knife edges, and a current is conducted into and out of the fine wire coil by two spirals of fine copper wire, *n*. The resistance of this coil is about 30 ohms and it is joined in series with an anti-inductive platinoid resistance, *R*, of 970 ohms. When the meter is in action a small current is kept passing through this circuit. The whole current to be measured is conducted through a fixed coil, *c*, of copper ribbon, which is placed with its plane parallel to the plane of the fine wire coil when the latter is in its zero position. A scale, *s*, divided to give readings in amperes is attached to the indicator, on which the strength of current passing through the fixed coil can be read off by means of an index fixed to the case of the instrument.

The recording apparatus consists of the train of counting

wheels, w, mentioned above and a revolving cam, x, driven by clock-work which is kept in motion by a weight, w. The cam is kept revolving at a uniform rate, and, when a current is passing through the instrument, comes in contact at each revolution with a trailing wheel attached to the counting train which it causes to turn round; and so makes a record.

The action of the meter may be shortly stated as follows:—When no current is passing the indicator stands at 0 on the scale, s, the movable coil is about 1 millimetre from the fixed one, and the trailing wheel of the counter train is quite clear of the cam, so that no record can possibly be made. When a current is passing through the fixed coil, the top end of the indicator is repelled outwards, and the counting train of wheels is brought inwards towards the cam to a position depending upon the strength of current which can be read off on the scale. In this position, at the proper time of the revolution, the trailing wheel is lifted by the cam, and runs over a shorter or longer path in proportion to the strength of current passing. Thus, if the current passing through the fixed coil be 5 ampères the counting wheels might record 20 for every revolution of the cam, whereas were the current 10 ampères the trailing wheel would roll over twice as long a path and the record would be 40.



Two screwed rods are so attached to the indicator that one, x, is vertical, and the other, y, is horizontal when the beam is in its zero position. These rods are provided with adjustable nuts—those on the vertical being to adjust the sensibility of the instrument, while those on the horizontal rod are for the adjustment of the zero. By means of the former the constant of the meter can be quickly varied if found convenient. Thus a meter which is suitable for measurement from 1 to 20 lamps can be altered in a few minutes to suit ranges of from 1 to 50 or from 1 to 100 lamps. This adjustment can be made by an inspector without the use of any auxiliary instrument. All that has to be done is to hang on a weight of a given amount on the knife-edge stirrup at the end of the horizontal arm and raise or lower the nuts on the vertical arm till the indicator shows a given reading on its scale.

By this means also the constant of the meter can be checked at any time.

As at present arranged the driving weight needs to be wound up periodically by means of a revolving disc on the front of the case. It is intended that this should be done by the consumer, and an arrangement is made by which the current is automatically cut off from the house when the weight is allowed to run down. Precautions are also taken to prevent any fraudulent tampering with the instrument.

### ON THE VALUES OF CERTAIN STANDARD RESISTANCE COILS.

By R. T. GLAZEBROOK, F.R.S.

(Presented to Section A, September 9th.)

THE Standard B.A. units of the Association have during the year been several times compared together both by the secretary and by Mr. Fitzpatrick. Table I. gives the results of two sets of comparisons made in August, 1890. The differences between the various coils and the platinum silver standard Flat are given in the third column in bridge-wire divisions. One bridge-wire division is very nearly 00005 B.A. unit.

TABLE I.

Resistance of the B.A. Standards, August, 1890.

Coil.	Temperature.	Difference between each coil and flat in bridge-wire divisions.		Observed calculated.	Change of resistance per 1° C. in b.w.d.
		Observed Aug. 15, 1890.	From chart. 1888.		
A	17.2	27.8	33.0	— 5.2	28.6
B	17.4	30.5	30.5	— 0.0	28.8
C	17.6	22.2	23.0	— 0.8	14.2
D	17.25	61.2	63.5	— 2.3	61.7
E	17.3	79.2	79.5	— .3	60.7
F	17.3	3.2	— 9.5	12.7	5.7
G	17.5	— 22.0	— 18.0	— 4.0	5.5
H	17.4	— 17.0	— 15.0	— 2.0	5.6
August 19					
A	18.8	67.5	69.5	— 2.0	28.6
B	17.8	60.6	62.0	— 1.4	28.8
C	19.2	31.6	36.0	4.4	14.2
D	18.8	145.7	15.1	5.3	61.7
E	19.0	170.6	17.3	2.4	60.7
F	18.9	2.9	— 9.5	12.4	5.7
G	19.0	— 21.8	— 18.0	— 3.8	5.5
H	19.0	— 17.7	— 15.0	— 2.7	5.6

In the fourth column are given the corresponding differences obtained from the chart made in 1888. In the next column will be found the differences between the observed values and those given by the chart, while the sixth column gives the change in resistance for 1° C. for the various coils. It will be seen that for the first five coils the differences between observation and the chart are such as would be readily accounted for by a small error in the temperature, and we may say that there is no evidence of a change in the resistance of these coils relative to Flat. This conclusion is borne out by the results of a series of observations made in January and February by Mr. Fitzpatrick. But when we come to the three platinum silver standards, F, G, H, the results are at once seen to be quite different. Thus F would appear to have risen relatively to Flat by about 12.5 bridge-wire divisions, while G and H have fallen by 4 and 2.5 divisions respectively.

Since these are the most important standards, their temperature coefficients being all very small, it was necessary to examine their history with some care. A change in F had been noted in a postscript to the report for 1888. The general conclusions of that Report were that up to the summer of 1888 there had been no change in the value of the coils. It was shown that all the original platinum silver coils examined then—those of Messrs. Elliott, H. A. Taylor, and others, as well as those belonging to the committee—had apparently fallen in value relatively to the mean B.A. unit by about 0007 B.A.U. since 1867, but evidence was adduced to show that the fall was only apparent and was due to an error in the temperature coefficient used at that date. A single observation of Chrystal in 1876 pointed to the possibility of a change in F, but that change was not confirmed by other evidence; while so far as the platinum silver coils were concerned, the observations of Dr. Fleming in 1881, and myself in 1888, agreed closely.

Since 1888, however, changes have shown themselves.

These are evidenced by the three following tables II., III., and IV., which give the differences Flat-F, Flat-G, and Flat-H respectively,

TABLE II.—Value of Flat-F.

Date.	Temperature.	Value.
Chart 1888 ... ..	10·0	10·5
	15·0	9·5
	20·0	8·5
May 16, 1888 ... ..	14·8	9·0
July 2, " ... ..	0·0	3·0
July 3, " ... ..	14·8	3·8
July 13, " ... ..	14·2	4·2
July 14, " ... ..	14·6	3·3
July 13, " ... ..	14·7	3·3
July 28, " ... ..	16·7	4·2
Jan. 27, 1890 ... ..	10·0	−4·0
May 31, " ... ..	14·4	−3·5
Aug. 15, " ... ..	16·9	−3·2
Aug. 29, " ... ..	16·7	−3·0

TABLE III.—Value of Flat-G.

Date.	Temperature.	Value.
Chart 1888 ... ..	10·0	17·5
	15·0	18·0
	20·0	18·5
July, 1888 ... ..	14·6	16·6
Jan. 27, 1890 ... ..	10·0	16·9
Jan. 29, " ... ..	4·5	16·7
Feb. 4, " ... ..	6·0	16·6
May 31, " ... ..	14·4	21·5
June 10, " ... ..	16·0	21·4
June 11, " ... ..	16·0	22·2
June 12, " ... ..	16·0	22·2
June 13, " ... ..	16·0	22·2
Aug. 9, " ... ..	19·0	21·8
Aug. 15, " ... ..	17·0	22·3
Aug. 29, " ... ..	16·5	22·6
Aug. 29, " ... ..	16·5	22·5

TABLE IV.—Value of Flat-H.

Date.	Temperature.	Value.
Chart 1888 ... ..	10·0	15·5
	15·0	15·5
	20·0	15·5
July, 1888 ... ..	14·6	14·1
Jan. 27, 1890 ... ..	10·0	17·5
Jan. 29, " ... ..	4·5	17·5
Feb. 4, " ... ..	6·0	16·5
May 31, " ... ..	14·1	18·3
June 10, " ... ..	16·0	18·1
June 11, " ... ..	16·0	17·7
June 12, " ... ..	16·0	16·4
June 13, " ... ..	16·0	16·8
Aug. 9, " ... ..	19·0	17·7
Aug. 15, " ... ..	17·4	17·0
Aug. 28, " ... ..	17·0	17·8
Aug. 29, " ... ..	16·4	18·2

The three first lines in each table give the differences at the temperature shown taken from the chart drawn in 1888; the remaining lines give the differences actually observed, with the dates and temperatures. Thus, taking the various coils, it is clear that while up to May, 1888, the difference between Flat and F remained the same as shown by the chart and observations up to that date, a change took place during the low temperature observations in July, 1888, while by the time the coils were again examined in January, 1890, a further change had manifested itself. This continues up to the present date, so that now at temperature of about 15 deg. the coil F has increased in resistance relatively to Flat by about 12·7 bridge-wire divisions. This, assuming the whole change to be in F, will correspond to a rise of resistance of '00063 B.A. units, or, in other words, the temperature at which the coil is right has fallen by about 2·3°. In January, 1890, the coils were again exposed to a low temperature, and it seems probable that the changes took place when the coils were in ice.

Turning now to Table III., which gives the values of Flat-G, we see there is no evidence of change till May, 1890. The observations in July, 1888, and January and February, 1890, are quite in accordance with the chart, but in May, 1890, it is clear that G has fallen relative to Flat.

The value of the difference at a temperature of 16° is 22·1 b.w.d.

as against 18·1 given by the chart. Thus G has fallen relatively to Flat by 4 b.w.d., or '0002 B.A. units. This change was first observed after the coils had been exposed to a low temperature.

With regard to H the change first showed itself during the low temperature observations in January and February, 1890, and Table IV. indicates that the difference between Flat and H is now 17·5 divisions as against 15·5 in 1888, or in other words, that G has fallen by '0001 B.A. unit. Also since Flat-F changed in 1888, while Flat-G and Flat-H did not, we infer that the change at that date was in F, not in Flat, while since Flat-H changed in January, 1890, without a change in Flat-G, it appears that the change was in H, not in Flat; and finally, from the observations in May, 1890, which show a change in Flat-G, but none in Flat-H and Flat-F, we infer a change in G.

As to the cause of these changes, we can say but little. We hope to investigate them more completely by the aid of the coils lent by Mr. H. A. Taylor and others, and referred to in the 1888 Report; but it seems possible that they are due to strains set up in the wire by the great contractions and expansions produced by cooling and heating in the paraffin in which the coils are embedded. The coil Flat is of a different shape to the others and little or no paraffin has been used in its construction. The other coils, F, G, H, are embedded in paraffin in the usual way. On cooling down to 0°, this shrinks greatly, and it is quite conceivable that this shrinkage may have strained the coils and so caused the change. We hope to test this by having coils made free from paraffin and investigating with them the effects of repeated heating and cooling. The fall of H and G would be accounted for by a loss of insulation causing a slight leak either from the wire to the case or across the surface of the paraffin. The insulation resistance for F, G, H, was therefore tested and found in each case to be several thousand megohms, while the surface of the paraffin which had become dirty with time, was scraped, but without producing any change in the resistance. A leak, of course, would not produce the rise found in F.

Observations of the coils at 0° have always been unsatisfactory and attended with considerable difficulty. This is mainly due, I believe, to the fact that the temperature of the room in which the observations have been made has usually been above zero, and that heat is conducted into the coils by the thick copper connecting rods. It would seem possible, however, that part of the difficulty (*See* Report of the Committee for 1888, Table VII.) may have been due to real changes in the resistance arising from strains set up by the cooling.

*The Legal Ohm Standards.*

The results of observations on the legal ohm standards of the Association are given in the Report for 1886. Experiments made in these between July, 1884, and January, 1886, showed that while one coil, C.L.C. 100, had retained its value unchanged, the other, C.L.C. 101, had varied. These observations have been continued, and the results are given in the following tables, which give the value of each coil as found by direct comparison with the standard B.A. units, and its value as given by the chart in 1886.

TABLE V.—Results for C.L.C. 100.

Date.	Standard used in comparison.	Temperature.	Value.	Value on Chart.	Difference.
Feb., 1887	F	16·3	1·00009	1·00008	·00001
Nov., 1889	G	15·8	·99997	·99996	·00001
"	"	14·8	·99971	·99968	·00003
"	"	16·0	·99998	1·00000	·00002
Dec., 1889	Flat	14·4	·99962	·99959	·00003
"	"	14·8	·99969	·99968	·00001
"	"	13·2	·99925	·99924	·00001
"	"	6·2	·99744	·99735	·00009
"	"	5·7	·99729	·99720	·00009

TABLE VI.—Results for C.L.C. 101.

Date.	Standard used in comparison.	Temperature.	Value found.	Value on chart in '85, '86.	Difference.
Feb., '87	F	16·3	·99970	·99930	·00040
Nov., '89	G	15·9	·99955	·99920	·00035
"	"	15·1	·99932	·99899	·00033
"	"	16·0	·99955	·99922	·00033
Dec., '89	Flat	14·4	·99909	·99880	·00029
"	"	15·0	·99925	·99897	·00028
"	"	13·3	·99879	·99850	·00029
"	"	7·6	·99725	·99695	·00030
"	"	6·5	·99701	·99668	·00033

These tables show three facts conclusively:—(1) That up to December, 1889, no appreciable change had taken place in the relative values of C.L.C. 100—the legal ohm standard—and Flat or G; (2) that between January, 1886, and February, 1887, C.L.C. 101, which had varied previously, changed by about '0004 ohms; and (3) that the greater part of that change has remained permanent up to December, 1889. At present the difference between

C.L.C. 100 and C.L.C. 101 is about '0004; in 1886 it was about '0008. The agreement between the observations in November and December, 1889—in one set of which Flat was the standard of comparison, while in the other G was used—show that the relative change in G and Flat took place after this date.

## DISCUSSION ON THE REPORT OF THE COMMITTEE ON STANDARDS.

(Tuesday, September 9th, 1890.)

The following discussion took place on the report of the committee, and the papers by Prof. Fitzpatrick and Messrs. Glazebrook and Griffiths:—

Prof. FITZGERALD said that he did not understand whether an attempt had been made to anneal the specimen of copper that gave the very abnormal density and low conductivity, or whether annealing would alter it. He also asked where the copper came from, because it would be interesting, in connection with the committee that had been appointed to make experiments on this abnormal copper, whose thermo-electric properties were also connected with this. He would like to find out where specimens could be got.

Dr. FLEMING answered the questions of Prof. FitzGerald, stating that he had obtained the copper from Mr. Elmore.

Mr. SWINBURNE remarked that in some American books, for instance, they gave a figure something like 784 as the most recent determination. But if there was any chance of an error of 4 or 5 per cent. in that, he thought it would be important to determine it again.

Mr. FLEMING said that one question raised seemed important in connection with changes in the coils, and that was the strains taking place in the wires as they were usually wound. Paraffin expanded and contracted during heating, and he was inclined to think that it would be better to use liquid paraffin. He was sure the members of the section fully appreciated the value of the work that Mr. Glazebrook was doing in keeping a careful watch on those coils for slow changes. Those coils constituted standards for all the world, and it was most important that a watch should be kept on them to detect normal changes. It was a most unfortunate fact that the standards were made of complicated alloys. The simple metals which would be better adapted for permanent standards having very high temperature coefficients. Some experiments had been carried out in the United States on alloys. One of these alloys was compounded some time ago by Mr. Weston, and Dr. Nicholls has published a paper on the matter. The alloys consist of copper nickel and ferro-manganese, and have a negative coefficient with change of resistance with temperature. It had been found that by suitable combination of these alloys it was possible to have an alloy that did not change its temperature. Unfortunately, however, these ferro-manganese alloys were not at all likely to be used, because they changed their resistance with small currents. His acquaintance with coil G had ceased for some time, but he had some recollection that that gold and silver coil gave them some anxiety. So far as he could follow Mr. Glazebrook, however, it was the coil F (platinum-silver) that had changed so much. This seemed to point to the necessity for more careful investigation of the changes of resistance and losses with time was required. With regard to the method of testing capacity with a revolving commutator, he had made experiments some years ago with satisfactory results. The commutator was driven by an electro-motor being keyed on to the motor shaft.

Sir WM. THOMSON was glad that Dr. Fleming had called attention to the loss of negative temperature coefficient, and said that it would be interesting for the section to know that the subject was under examination in Dr. Helmholtz's laboratory. If there was no temperature variation, they might soon hope to see coils in which they would not be troubled with any temperature error.

Mr. TROTTER said that since the B.A. Committee were dealing with the resistance of copper, it might be important to determine what was meant by copper. Tempering produced a very large change, and the expression "thorough tempered" was used. But surely, if tempering did produce any change, they ought to know what was meant by "thorough tempering." It was perfectly well known that ordinary commercial copper contained a considerable amount of oxygen. The question arose, What amount of oxygen or hydrogen might be occluded in deposited copper. It was not a purely chemical question, and should be determined.

Sir WM. THOMSON remarked that the time occupied in thorough tempering was important. It might extend over hours, days or weeks, and might produce very different results.

Prof. FITZGERALD said that that fact seemed to make the difference between pure and impure metals.

Mr. GLAZEBROOK said that the numbers in Table II. gave the resistance of the same wire that had been tested there after it had been annealed. In the one column they had the resistance of hard-drawn wire, and in the other after annealing. The annealing was done by enclosing the wire in a flat copper case, packed full of asbestos and lampblack, heating it with a Bunsen burner, and leaving it for 24 to 26 hours. In every case the numbers in the table gave the results of more than one annealing. The process of annealing was repeated again and again, and the numbers gave the mean result of as perfect annealing as could be arranged for.

Sir WM. THOMSON suggested that the use of lampblack and the

consequent presence of carbon might have a very important effect on the result, and he thought it would be well to try annealing with asbestos alone.

Dr. LODGE asked whether the section were to run away with the idea that there was something the matter with the platinum-silver alloy. Mr. Glazebrook had told them that the platinum-silver coil might be all right, but coil F had changed. He would like to know whether it had changed by more than one part in 10,000.

Prof. PERRY remarked that in some observations which he had recently been making on wires, strips of the same wire, after being flattened and twisted, behaved in such a different way as regards their elasticity that they might almost be thought to be made of different material.

Lord RAYLEIGH, in connection with the impurities of copper, mentioned some experience he had gained during last summer. In passing pure hydrogen over copper wires at a red heat, he found that the gas reeked of sulphuretted hydrogen. It was impossible to get copper that did not give off sulphur. When the wires were taken out after heating, they were absolutely brittle, suggesting the idea that the removal of the sulphur had been fatal to their mechanical properties.

Mr. SEARLE having described the methods he had adopted for rotating the commutator,

Mr. GLAZEBROOK replied to the questions and suggestions that had been made. With regard to what had been said as to annealing, he was afraid that in endeavouring to be brief, he had not been quite just to the very great care Mr. Fitzpatrick had taken on this point. There was a great feeling among copper manufacturers that a small amount of oxide was necessary to give density to copper wire, and there was a certain amount of oxide in all copper. The original reason why it was annealed in charcoal was to get rid of that oxide, and he fancied that in almost all cases the wire did turn out brittle. At the same time it came out with a very much reduced resistance. In Mr. Fitzpatrick's method of preparing the copper, the hydrogen was passed over the copper at a red heat for a considerable number of hours. Mr. Fitzpatrick had a specimen of copper prepared by chemical means, the results of observations on which he had hoped to have had there that day, had not the breaking of a tube (obtainable only in Germany) postponed the reduction and purification of the copper until another could be got. But he fancied the copper did become distinctly brittle, and lose its density when the sulphur was got rid of. As to Mr. Taylor's remarks about Matthiessen's knowledge of the temperature coefficient, he had his formula there, and he thought the number was obtained by ranging from 16 to 100. He had not been able to find any observations of Matthiessen lower than 16; if Mr. Taylor had numbers nearer 0, they would be extremely valuable to the report. Dr. Fleming had referred to the point he (Mr. Glazebrook) raised as to the effects of mechanical strain. It would be in the memory of the section that in the last clause of the report he asked for further resistance coils. It was his intention to wind these entirely without paraffin. As to the loss with negative temperature coefficient, they had been in communication with the Helmholtz laboratory, and they hoped to have specimens of wires before long. With regard to the platinum silver alloy, his impression was that there had been no change in the alloy, but that a mechanical change had been produced by strain, and he hoped that any electricians who had old coils of the Association would lend them to him again that he might compare them, and see if there had been any change. The amount of change in F was a rise of

+ '0007 B.A. unit.  
G — '0002 do.  
H — '0001 do.

He thought Prof. Perry's remarks entirely bore out his experiments. Mr. Searle said he had only taken a subsidiary part in the matter, but he made the commutator, and made it work, and that was of great importance.

The PRESIDENT (Dr. Glaisher) congratulated Mr. Glazebrook on the satisfactory nature of the report.

## ON THE ELECTROSTATIC FORCE BETWEEN CONDUCTORS CONVEYING STEADY OR TRANSIENT CURRENTS.

By Dr. OLIVER LODGE.

(Presented to the A Section, September 9th, 1890.)

At the last meeting of the Physical Society this session, Mr. Boys described some attempts he had made to detect mechanical force between a pair of Hertz resonators delicately suspended and immersed in a region of electromagnetic waves.

The attempt, so far, had not been successful; but Mr. Boys, by attending to the energy manifested by Mr. Gregory's method, and by another method of his own, showed good reason why the force, if any, was just too small to be observed even with his extremely delicate appliances, and conjectured that a moderate increase in sensitiveness would be necessary in order to detect the effect.

Every one must have full confidence that if any such mechanical effect exists, Mr. Boys will show it us before long; but, in common with Prof. Fitzgerald, I feel provisionally and tentatively doubtful whether any mechanical effect really exists between electric pulses travelling along wires with the velocity of light. In a wire subject to electric stationary waves there are obvious

electrostatic pulses at either end and electrokinetic pulses in the middle: but Mr. Boys had allowed for all that, and arranged that the opposing effects of ends and middle should conspire to assist each other in causing rotation. What I felt doubtful about was, whether even in infinite wires, wherein all complication by reflection and stationary waves was avoided, a pair of pulses travelling side by side, like a pair of humps (or a hump and a hollow) on a pair of parallel cords, would exert any force on each other. It is known that two charged bodies flying side by side with the velocity of light will exert no such effect (Mr. Heaviside has shown that this is equivalent to saying that two elements in the same wave-front exert no mechanical force on each other); but whether the same thing is true of two wire-conducted pulses has not, so far as I know, been examined by mathematicians.

If it should turn out that pulses at full speed have no effect, then two straight oscillators in similar phases should repel each other, by the electrostatic effect of the slackening and stationary pulses which are being reflected at the ends.

Such an action seems optically rather interesting. Maxwell predicted that a reflector or absorber would be repelled by light; though, as we know, the complication of the more vigorous molecular action of material surroundings prevented Mr. Crookes from detecting this precise effect. We know, however that it must exist; and the repulsive effects between alternating magnets and copper discs, detected by Faraday and recently made much of in an interesting manner by Prof. Elihu Thomson, are examples of this very thing. We can even say what the stress caused by full sunshine ought to be, viz., about 50 microbarads;\* that is, the weight of half a milligramme per square metre; but it has not yet been experimentally observed. If Mr. Boys finds his effect, at least if he finds it in the form I suggest, as an overbalancing static repulsion, it will represent an action between two sources of light or between two similarly illuminated bodies.

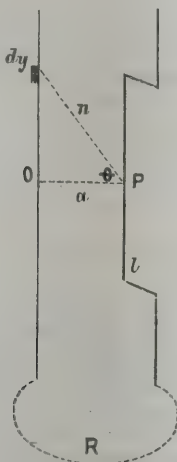
On the afternoon of the meeting of the Physical Society, by Mr. Boys's kindness, I made in a back room a hasty experiment on the pulses of a Leyden jar discharge, which was passed either in the same or in opposite directions through a pair of flexible parallel strips of aluminium foil, looked at through a microscope.

A fairly distinct effect was observed, its sign being, so far as one could tell, the sign of the electrokinetic effect; i.e., attraction between currents in the same direction, repulsion (more easily observed, because, as it was arranged, nearly four times as strong) between opposing currents. Hence it would seem, so far as this crude observation goes, that pulses in wires do exert their electrodynamic effect. I expected, however, that, by suitably arranging matters, the electrostatic effect of the pulses could be made able to overpower their electro-magnetic effect. It is perhaps rather a barbarous plan to consider the two things separately; but until some one attacks the problem in a powerful manner I have been interested in groping at it, and accordingly make this communication.

First, consider the action of currents in general on each other, and find the ratio between their electrostatic and electrokinetic forces. So far as I know, the electrostatic force between two steady currents is usually overlooked.

No advantage in generality is gained by treating two separate circuits, a movable portion arranged near a fixed portion of one and the same circuit is sufficient.

Arrange a short length,  $l$ , at a distance,  $a$ , from a long parallel conductor; with a resistance,  $R$ , intervening between  $o$  and  $P$ , the middle opposite points of each; and through the whole send a current,  $c$ , up one and down the other.



Then the difference of potential between the two points is  $Rc$ , or, with alternating currents,  $Pc$ , where  $P$  is the impedance of the wire  $R$ ; and if the capacity per unit length of the two conductors is called  $s_1$ , the linear density of charge on each is on the average  $\lambda = s_1 Rc$ ; a little more above  $o$  and a little less below it; but unless the distribution of potential differs greatly from a linear

distribution, as when  $l$  is comparable to a wave-length, the mean value will serve.

The electrostatic attraction between the two conductors is

$$F = \int_0^l \int_{-\infty}^{+\infty} \frac{\lambda dy \cdot \lambda' dy' \cdot \cos \theta}{K r^2} = \int_0^l \int_{-\frac{1}{2}\pi}^{+\frac{1}{2}\pi} \frac{\lambda dy \cdot \lambda' \cos \theta d\theta}{K a} \\ = \frac{2 \lambda \lambda' l}{K a} = \frac{2 l}{K a} (s_1 R c)^2 \quad (1)$$

Unless one of the conductors is very long there is another term, which, however, it is unnecessary to write.

The electrokinetic repulsion between the same conductors is similarly

$$F' = \int \int \frac{\mu c dy c' dy' \cos \theta}{r^2} = \frac{2 \mu l}{a} \cdot c^2 \quad (2)$$

#### Steady Currents.

Hence with steady currents the ratio of the static attraction to the magnetic repulsion is

$$\frac{F}{F'} = \frac{s_1^2 R^2}{\mu K}, \quad (3)$$

which on every possible system of units is a pure number.

To get a notion of its value, suppose the wires to be round and of radius  $\rho$ ; then

$$s_1 = K \cdot 4 \log \frac{a}{\rho};$$

so, remembering that

$$\frac{1}{\mu K} = (\text{the velocity of light})^2 = \left( \frac{30 \text{ ohms}}{\mu} \right)^2,$$

we see that the above numerical ratio is

$$\frac{F}{F'} = \left\{ \frac{\text{number of ohms in the wire } R}{120 \log \frac{a}{\rho}} \right\}^2 \quad (3')$$

Suppose, for instance, the wires were 50 diameters apart, or  $4 \log a/\rho = 18.4$ , the two forces would be equal, and just balance each other, if  $R$  was 552 ohms.

With any resistance greater than this the electrostatic force would have the advantage, and two opposite currents in the given wires would attract.

#### Alternating Currents.

If the current used is an alternating one, impedance must be inserted in (1) and (3) instead of resistance: no other change is necessary. Hence an impedance meter suggests itself. Send a current alternating with given frequency through the pair of conductors joined by the impedance to be measured, and either adjust  $s_1$  until the electrostatic and electrodynamic forces balance, or estimate the outstanding force by a torsion arrangement. Supposing a balance could be got, the impedance of the intervening conductor, for the particular frequency applied, is

$$P = \frac{1}{s_1 \cdot v} = 60 \log \frac{a^2}{\rho \rho'} \text{ ohms.}$$

#### Leyden Jar Discharge.

Next proceed to consider the transient current of a Leyden jar discharge round the same circuit.

Let a jar of capacity  $s$  charged to potential  $v_0$  be discharged round a circuit whose total resistance and inductance are  $R_0$  and  $L_0$  respectively. Then the current at any instant after the discharge has begun is

$$c = \frac{v_0}{P L_0} e^{-m t} \sin p t; \text{ where } m = \frac{R_0}{2 L_0}, \text{ and } m^2 + p^2 = \frac{1}{s L_0}.$$

The electrodynamic repulsion between the two wires previously considered, when the discharge occurs, is, therefore, applying (2), an impulse:—

$$\phi' = \frac{2 \mu l}{a} \cdot \left( \frac{v_0}{P L_0} \right)^2 \int_0^\infty e^{-2 m t} \cdot \sin^2 p t \cdot dt \\ = \frac{2 \mu l}{a} \cdot \frac{1}{2} s v_0^2 \cdot \frac{1}{R_0} \quad (4)$$

To investigate the electrostatic attraction completely we should have to take into account the sinuous distribution of potential in space over the circuit; but, unless the waves are much shorter than usual, the ultimate effect on a short length will be very little different from the effect of a uniform potential alternating sinusously in time, the difference of potential at any instant between the fixed and movable wire being

$$V = P c,$$

where  $P$  is the impedance of the intervening portion of the circuit. Hence the electrostatic impulse is, by (1),

\* Langley's recent estimate, that a square centimetre fully exposed to sunshine receives 2.84 C.G.S. thermal units per minute, is equivalent to an energy of 67 ergs per cubic metre of sunshine, or 67 microbarads. (A "barad" means an erg per cubic centimetre, or a dyne per square centimetre.)

$$\phi = \frac{2l}{\kappa a} s_1^2 P^2 \int_0^\pi c^2 dt$$

$$= \frac{2l}{\kappa a} \cdot \frac{\frac{1}{2} s v_0^2}{R_0} \cdot s_1^2 P^2. \quad (5)$$

And the ratio of the two impulses is

$$\frac{\phi}{\phi'} = \frac{s_1^2 P^2}{\mu \kappa} \quad (6)$$

Now  $P^2 = p^2 L^2 + R^2$ , where  $p^2 = \frac{1}{s L_0} - \left( \frac{R_0}{2 L_0} \right)^2$ .

So, noticing that  $R/R_0 = L/L_0$  as nearly as we please,

$$P^2 = \frac{L}{L_0} \left( \frac{L}{s} + \frac{3}{4} R_0^2 \right).$$

The second term is frequently negligible, though there is no difficulty in taking it into account if it is not; so the ratio of the impulses, at its least is

$$\frac{\phi}{\phi'} = \frac{s_1^2}{\kappa^2} \cdot \frac{L}{L_0} \cdot \frac{L/\mu}{s/\kappa}. \quad (6')$$

The first of these three numerical factors depends merely on the shape of the acting conductors and their distance apart. The second is a proper fraction which may be made as near unity as we choose. The third involves a comparison between the electro-magnetic measure of inductance of the wire included in the circuit, and the electrostatic measure of capacity of the discharged Leyden jar.

Taking as an example the same round wire conductor as before, with

$$s_1 = \frac{\kappa}{4 \log \frac{a}{\rho}} = \frac{\kappa}{18.4}, \text{ say,}$$

and considering  $\frac{L}{L_0}$  as  $\left( \frac{18.4}{20} \right)^2$  for instance, we perceive that

the two impulses will be equal and just balance each other if the length representing  $L$  on the magnetic system of units be 400 times as great as the length representing  $s$  on the electrostatic system. Any wire longer than this gives attraction the advantage; any wire shorter than this favours repulsion.

Or, with different jars discharging round a given circuit, small jars will exhibit the electrostatic impulse, big ones the electrokinetic.

Illustrating numerically still further; a length of 30 metres of No. 16 copper wire opened out into a single large loop has a self-induction of 500 "metres" or 50 micro-secohms. Using this as the wire  $R$  between the two suspended conductors, the critical sized Leyden jar which should excite no force when discharged through them is about  $1\frac{1}{2}$  "metres" or .00014 microfarad; i.e., smaller than the ordinary "pint" size.

With the help of an adjustable condenser, an instrument for measuring the  $L$  of well-insulated coils free from iron suggests itself here.

#### Ribbon Conductors.

If strips are used instead of round wires for the movable conductor, the electrostatic effect has an artificial advantage given it: for take a pair of similar strips, of length  $l$ , breadth  $b$ , and distance apart  $a$ , the force caused by a current  $c$  flowing through them with uniform intensity everywhere is easily calculated to be

$$\frac{4 c^2 l \mu}{a} \left( \frac{a}{\tan \alpha} + \frac{\log \cos \alpha}{\tan^2 \alpha} \right),$$

where  $\alpha$  is an angle whose tangent is  $b/a$ .

The quantity in brackets has a maximum value  $\frac{1}{2}$  when  $\alpha = 0$ , i.e., when the plates are far apart enough for their shape to be immaterial; and its value decreases steadily towards zero, viz.,  $\frac{1}{2} \pi \cot \alpha$ , as  $\alpha$  approaches  $90^\circ$ ; the whole becoming ultimately  $2 \pi \mu c_1 \cdot cl$ .

As for the electrostatic force between strips, I do not know how far we are justified in assuming uniform distribution of density, even if given uniform distribution of current; but at least when the plates are close together the force will not be very different from

$$2 \pi \cdot \frac{s v}{\kappa a} \cdot s v = \frac{2 \pi l}{\kappa b} \cdot (s_1 P c)^2;$$

the value of  $s_1$  being  $\frac{\kappa b}{4 \pi a}$ .

So the ratio of the forces for large close plates is

$$\frac{\kappa}{\mu} \cdot \left( \frac{P b}{4 \pi a} \right)^2 = \left( \frac{\text{No. of ohms in impedance of wire}}{120 \pi a/b} \right)^2.$$

Hence with strips six times as broad as their distance apart the forces will balance for a steady current when the interposed wire is only 60 ohms resistance.

#### Measure of "v."

In applying an experimental observation of this kind to a determination of the product of the ether constants  $\mu, \kappa$ , (and it just strikes me that it is after all only a modification of the method

by which Maxwell himself made one of the early determinations), it will be better to use round wires rather than strips, because linear dimensions then come in only under a logarithm, and moreover are such as can be measured with considerable accuracy without difficulty. Some of Mr. Boys's quartz-fibre and aluminium tube devices ought to permit the zero of force to be sharply got, and thus a good measure of "v" to be made.

We should have to observe very exactly the neutralisation of all force between the suspended and fixed conductors while a steady current was passing through them, with an interposed wire of known resistance, and then use the relation (3) or (3') in the form

$$\mu \kappa = s_1^2 R^2,$$

or

$$"v" = \frac{s_1}{\kappa} \cdot \frac{R}{\mu} = \frac{\text{resistance of wire expressed as a velocity}}{4 \log \frac{a}{\rho}}. \quad (7)$$

If the acting conductors are set very near each other,  $a$  being still the distance between their centres, the denominator alters itself a little, becoming

$$2 \log \frac{a^2 - 2 \rho^2 + a \sqrt{a^2 - 4 \rho^2}}{2 \rho^2},$$

with an easy additional complication if it is convenient to make the sectional radii unequal.\*

By filling the vessel containing the acting conductors with other insulating media, it is possible that the "a" for them could be directly measured.

#### Action of Moving Charges and Pulses.

So far I have not taken into account the sinuosity of distribution of Leyden jar discharges in space, nor the possibility of pulses passing the two portions of the circuit between which the force is being observed at different times or in different phases. It would seem as if a small assemblage of short-waved pulses sent round a long circuit might be prevented from exerting any mechanical action on each other if the adjacent parts of the circuit in which their action was to be observed were purposely separated by an intervening length of wire of many wave-lengths unsymmetrically introduced into the circuit. But before committing myself I should like to make a few experiments. Nevertheless I am tempted to go on a little further.

If, instead of considering pulses rushing along stationary wires, we consider charged wires moving along endways with the speed of light, Mr. Heaviside has attacked the general problem in the *Philosophical Magazine* for April, 1889. He there shows that between two planes perpendicular to a wire thus moving and moving with it at a distance apart equal to the length of the wire, the electrostatic intensity is

$$E = \frac{2 \lambda}{\kappa r},$$

and the magnetic intensity is

$$H = \frac{2 \lambda v}{r},$$

where  $\lambda$ , the linear density, may be distributed anyhow on the wire. Outside these two planes the force is zero.

If the two intensities were to act, one on a stationary charge of any number of electrostatic units, the other on a stationary magnetic pole of the same number of magnetic units, the two forces would be equal. If they act on a wire conveying a steady current, and charged up to a certain linear density, the forces will be equal when the statical measure of density is equal to the magnetic measure of current, i.e., when  $c = v \gamma$ ; for then

$$E \lambda = H \mu c.$$

Lastly, if the two forces due to one bit of charged wire, moving in its own line with the speed of light, act on another similarly moving piece, the current equivalent to the second wire will be  $v \lambda'$ ; and again there will be an equality between electrostatic and electrokinetic forces;

$$\frac{2 \lambda}{\kappa r} \lambda' = \frac{2 \lambda v}{r} \cdot \mu \lambda' v.$$

Not by any different  $\lambda$ , or by any rearrangement of  $\lambda$ , can the balance be disturbed: only by a different  $v$ . If either wire moves with velocity less than that of light, the electrostatic force overpowers the other, but, so long as the full velocity is maintained, the density on either wire may have any value, positive or negative without disturbing the balance; and this is natural enough, when, as here,  $\lambda$  and  $c$  vary together; for if  $\lambda$  be zero or negative anywhere,  $c$  is also zero and negative, and the balance persists.

Now proceed to the case of alternating pulses travelling along parallel stationary wires. Their speed of travel is the speed of light, and though the distribution of both density and current is sinuous there is nothing in that disturbing to a balance; moreover, so long as the waves are freely progressive,  $\lambda$  and  $c$  still accompany each other exactly, and nothing but a balance will be observed in a closed circuit, however, the phases operating in the acting portions be altered, if the right proportion holds between the current and the potential, as already calculated.

But if by reflection at distant unjoined ends of an open circuit the pulses be turned from progressive into stationary waves, then

\* See Foster and Lodge, *Phil. Mag.* June, 1875, p. 456.

localities can be found on the wires at which attraction or repulsion permanently occurs; for  $\lambda$  and  $c$  are no longer companions, the sinuous distribution of current lags a quarter period behind the sinuous distribution of charge. Hence at a given instant there will be places where the current force is a maximum and the static force zero; while at a quarter wave-length on either side the current force is zero and the static force a maximum. Halfway between these places only will the two forces be equal, but with alternate agreement and disagreement of sign. A readjustment of phase between the conductors will now make all the difference; a shift of a quarter wave-length changing from maximum to zero, and a shift of half a wave-length bringing about reversal of sign.

According to all this, therefore (if it be correct) it follows that the simple ideas on which Mr. Boys set to work are right after all, and that he will detect the forces in the way he expects.

#### Variation with Distance.

A few words as to the magnitude of the effect to be expected. Hertz has shown (see *Nature*, Vol. XXXIX., p. 404) that at a reasonable distance from a rectilinear oscillator, one or two wave lengths being practically sufficient, the electric force (or electromotive intensity) is perpendicular to the radius vector from middle of oscillator, and is of magnitude

$$E = \frac{q l q^2}{\kappa \rho} \cdot \sin(q\rho - pt) \cdot \sin\theta; \quad (8)$$

where  $\rho$  and  $\theta$  are the polar co-ordinates of the place, and  $q = 2\pi/\lambda$ .

Calling the length of the oscillator the axis, and the normal plane through its middle the equator, this means that the electric force is a maximum at the equator, diminishes towards the poles, and varies along any radius with the inverse distance from the centre.

At smaller distances the law is not so simple, but at any distance in the equatorial plane the electric oscillation is parallel to the oscillator, and of amplitude

$$\frac{q l}{\kappa r^3} \sqrt{(q^4 r^4 - q^2 r^2 + 1)},$$

showing that close to the oscillator the electric force varies as the inverse cube of the distance; at intermediate distances more slowly, while at a very few wave-lengths (practically one is sufficient) the first term under the root overpowers the others, and the ordinary law of the inverse distance holds good.

To get an idea of the magnitude of this intensity at any considerable distance from the axis, write  $q = sv$ , where  $v_0$  is measured by the length of spark employed at the oscillator, and

write for  $q^2$  its value  $\frac{\mu \kappa}{L s}$ ; then the amplitude of the electric force is

$$E = \frac{svl \cdot \mu \kappa \cdot \sin\theta}{\kappa \rho \cdot L s};$$

or, as  $L = 2l\mu \left( \log \frac{4l}{d} - 1 \right) = 2\mu lc$ , say,

$$E = \frac{v \sin^2\theta}{2rc} \quad (9)$$

Take as a numerical example any convenient oscillator, say, to avoid unnecessary repetition of specification, the small oscillator drawn to scale on page 54 of the *Philosophical Magazine* for July, 1889, which emits waves 1 metre long; let its constant  $c = 4\frac{1}{2}$ , and its spark be, as there quoted, 8 millimetres, so that  $v_0$  is about 26,000 volts. Then the initial electric intensity at a distance of a couple of wave-lengths in the equator is

$$E_0 = \frac{26,000 \text{ volts}}{18 \text{ metres}}$$

$$= 14.4 \text{ volts per centimetre.}$$

Putting, therefore, at this distance of 2 metres a parallel wire half a wave-length long as receiver, it utilises 50 centimetres of the above electromotive force, and gives a maximum sparking potential of 720 volts, which corresponds to a spark-gap of about a tenth of a millimetre between flat surfaces. This is an upper estimate, because time for a quarter-period's dissipation should be allowed, the result being multiplied by a dissipation factor  $\exp$ .

$\left( -\frac{4\lambda}{vs} \right)$ ; where  $R$  is to be found as follows.

#### Energy of Radiation.

The mean energy of the radiation per unit volume is, as is well known (Maxwell, art. 793),  $\frac{\kappa E^2}{8\pi}$ , which in the present case, abbreviating the characteristic factor,  $\left( \log \frac{4l}{d} - 1 \right)$  or its equivalent, to  $c$ , is,

$$\frac{\kappa}{8\pi} \cdot \frac{v^2 \sin^2\theta}{4\rho^2 c^2} \quad (10)$$

The energy sent per second through the sphere of radius  $\rho$  with velocity " $v$ ," is

$$\begin{aligned} & \int_0^\pi 2\pi\rho \sin\theta \cdot \rho d\theta \cdot \frac{\kappa v^2 \sin^2\theta}{32\pi\rho^2 c^2} \\ &= \frac{4}{3} \cdot \frac{\kappa v^2}{16 c^2} \\ &= \frac{v^2}{12\mu v c^2} \quad (11) \end{aligned}$$

And this is the rate at which the oscillator radiates energy during its activity. Comparing (11) with (10) we see that the equatorial radiation exceeds the mean radiation in the proportion of 3:2.

The difference of potential  $v$  is not constant, but decreases logarithmically according to the law

$$v = v_0 e^{-\frac{t}{R}};$$

where  $R$  is a dissipation-coefficient of the dimension of resistance, and of value easily found, thus:—

Total energy radiated for every spark of the oscillator is

$$\int_0^\infty \frac{v_0^2 e^{-\frac{2t}{R}}}{12\mu v c^2} dt = \frac{1}{2} \frac{v_0^2 \cdot R}{12\mu v c^2},$$

which must also equal  $\frac{1}{2} v_0^2$ , the initial energy; hence

$$R = 12\mu v c^2 = 360 c^2 \text{ ohms.}$$

Taking as a numerical example the same oscillator as above, with  $c = 4\frac{1}{2}$  and  $v = 88$  electrostatic units, all these values are easily estimated. For instance, the mean energy of the radiation per unit volume at any considerable distance  $r$ , say 2 metres, in the equator, is

$$\frac{\kappa v^2}{32\pi c^2 r^2} = \frac{88 \times 88}{25 \times 81 r^2} = \frac{3.8}{r^2} = \frac{3.8}{4 \times 10^4} \text{ barads}$$

= 95 microbarads, at a distance of two metres.

This will cause a momentary pressure on a metallic surface normally exposed to it, of 95 microdynes per square centimetre, or a milligram weight per square metre; and is nearly twice as strong as full sunshine while it lasts.

At 1 metre distance, I need hardly say, the energy and pressure are four times as great.

The area of energy absorbed by a fine wire linear receiver may be estimated roughly by finding the closeness of a grid of parallel wires which would just not let any radiation pass through it. Suppose, for instance, that a grid with wires 10 centimetres apart satisfies this condition; then each wire mops up energy for a breadth of 5 centimetres on either side of itself. The heat generated in such a wire at each spark is

$$\frac{3}{2} \cdot \frac{b l}{4\pi r^2} \cdot \frac{1}{2} s v_0^2.$$

This, in the numerical case already taken, with  $\frac{s}{\kappa} = 1.4$  centim.

and  $\kappa v_0^2 = (88)^2$  dynes, gives, at a distance of 1 metre,

$$\frac{3 \times 590}{25 \times (100)^2} \times 7 \times (88)^2 = 32.5 \text{ ergs per spark;}$$

which, repeated 100 times a second by a suitable contact-breaker, would yield 3,250 ergs per second, or 1 ordinary thermal unit every  $3\frac{1}{4}$  hours.

The dissipation-factor, mentioned at the end of last section, is

$$e^{-\frac{100}{1.4 \times 12 \times 81}}$$

#### Attempt at further detail.

To work out more completely what happens when one oscillator is used to excite another arranged parallel to it at an equatorial distance  $r$ , not near enough to re-act, I suppose we may consider the receiver as subjected to an impressed E.M.F. given by (8), and write down the equation to its current  $x$  at any instant,

$$x + 2\kappa \dot{x} + n^2 x = \frac{l' v_0 e^{-m't} \sin(qr - pt)}{2rc} \quad (12)$$

the solution of which is given (for instance) in Lord Rayleigh's "Sound," Vol. I., p. 62.

The heating of the receiver at each spark will be  $\int_0^\infty R' \dot{x}^2 dt$ .

If there be two such receivers, far enough off each other not to encroach on each other's field, the current attraction between them will be proportional to  $x_1 x_2$ , and the static repulsion to  $x_1^2 x_2^2$ .

Calling the right-hand side of the above equation  $v$ , and writing  $n'^2 - \kappa'^2 = n^2$ , the complete solution is

$$\begin{aligned} x &= \frac{1}{n} \int_0^t e^{-\kappa(t-t')} \sin n(t-t') \cdot v' dt' \\ &+ \frac{e_0}{\cos} \cdot e^{-\kappa t} \cos(n t - \gamma); \quad (13) \end{aligned}$$

where  $v'$  is the same function of  $t'$  that  $v$  is of  $t$ , and where

$$\tan \gamma = \frac{x_0}{nx_0} + \frac{\kappa}{n}.$$

The second term in the above, which expresses free vibrations in the receiver, may be made zero, because it contains the initial disturbance of the receiver as a factor; and the first term, which expresses forced vibrations, simplifies down to

$$x + c = \frac{l'v_0}{4nrc} e^{-mt} \left( \frac{\sin \alpha}{p-n} \cos(qr-pt+\alpha) - \frac{\sin \beta}{p+n} \cos(qr-pt+\beta) \right), \quad (14)$$

where  $\tan \alpha = \frac{p-n}{\kappa-m}$ , and  $\tan \beta = \frac{p+n}{\kappa-m}$ .

If there is anything like agreement between the natural periods of vibrator and resonator, the first of these two terms overpowers the other.

Another way of writing the solution is

$$x + c = \frac{l'v_0}{4rcn} \frac{\sin(\beta-\alpha)}{\kappa-m} e^{-mt} \sin qr - pt + \alpha + \beta. \quad (15)$$

#### Appendix.

It is in accordance with theory to assert that the action of two given magnets on each other varies inversely with the permeability of the medium; that the action of two currents on each other varies directly as the permeability of the medium; and that the action of a current on a given magnet is independent of the properties of the medium.

To avoid misunderstanding, it must be perceived that the statement refers to a given magnet, not to a magnet of numerically specified strength, because about that there would be some ambiguity according to the medium in which it was measured.

Similarly, the static action between two charges is inversely as the dielectric constant of the medium; the action between a given charge moving at the approximate light speed and a given magnet is independent of the medium, except in so far as its properties affect the velocity of light; while the dynamic action between two given charges moving together at the light speed is proportional to the permeability.

It may be as well to have direct experimental verification for some of these things.

#### LEGAL.

**Watt v. Maxim-Weston Company, Limited—Maxim-Weston Company, Limited v. Watt.**—On Wednesday, before Mr Justice Vaughan Williams (vacation judge), sitting in the Chancery Division of the High Court of Justice, Mr. E. Morten applied *ex parte* in the above actions, which would shortly come before Mr. Justice North for trial, for an order for the examination of a witness before a special examiner. The actions involved a great many issues, one important thing being to unravel the dealings which had taken place in the shares of the company at the instance of Mr. Watt, the chairman of the company. For this purpose it would be necessary to have the evidence of the stockbroker who carried out the transactions on the Stock Exchange for Mr. Watt. Information had been just received that Mr. Barnard, the stockbroker in question, was about to depart for America in search of sport, which was likely to keep him there for the next six months. That being so, it was desired to take the examination early next week. In the case of *Bidder v. Brydges*, the Court had held that such an order would be made where necessary for the purposes of justice.

HIS LORDSHIP said he was somewhat loth to make the order *ex parte*, but he would do so upon conditions. It was quite plain the examination could not be conducted effectively unless the other side had notice and the opportunity of being present. The order would go, but would contain upon its face the condition that notice should forthwith be given to the other side, and that they should be at liberty to apply to discharge the order.

**Woodhouse and Rawson, Limited.**—A motion for the removal of the liquidators of this company, for the appointment of others in their place, and to restrain further dealing with the assets, was in the list for hearing, but Mr. Baker stated that, by consent, it had been arranged that the motion should be withdrawn from the paper, no order being made upon it.

HIS LORDSHIP acceded to the application.

**The City Lighting.**—The City Commissioners of Sewers, at the instance of the Streets Committee, on Tuesday, resolved to invite tenders for lighting by electricity the western districts of the City on similar conditions to those arranged for the east and central districts, but intimating that should any deviation from such conditions favourable to the Commissioners be desired by the companies tendering, such deviation must be specifically set forth.

#### NOTES.

**Electric Lighting in Hampshire and Sussex.**—The electric light is making considerable progress in Hampshire and Sussex. At Portsmouth, the special committee which has been appointed to consider the steps to be taken to introduce the light into the borough, are about to retain the services of an eminent electrician. The Winchester Council have determined to send a deputation to Fareham, where the electric light is in full operation. At Lewes last week a public meeting of the ratepayers was convened by the mayor for the purpose of considering the question of street lighting. A long discussion ensued, and eventually it was determined to adjourn the matter for a fortnight.

**Electric Lighting in Pemberton.**—The Local Board of Pemberton, in Lancashire, are just now having a portion of their district lighted by electricity by way of experiment; and it is understood that if the experiment—which will extend over two months—is of a satisfactory character, this means of illumination will be adopted in substitution for gas. Messrs. Mercier and Corlett, of Wigan, have put down the plant for this experiment. Lighting commences at dusk and continues until 10 o'clock.

**Electric Lighting in Nelson.**—The Gas Committee of the Nelson Corporation have under consideration a scheme for the lighting of the town by electricity instead of gas as at present.

**Lighting at Northampton.**—The central station of the Northampton Electric Light and Power Company, Limited, is being erected by Messrs. Crompton and Co., Limited, who are also doing the wiring of the hotels, houses, shops, &c., to be lighted. Mains are already laid in several of the streets and current will shortly be available.

**The Electric Light at Exeter.**—The Exeter City Council held a meeting on Monday to consider an application from the Electric Light Company and a recommendation from the special committee on electric lighting that steps should be taken to obtain a provisional order for the Council. Mr. Alderman Andrew proposed: "That, inasmuch as any monopoly of the supply of electric light was rendered impossible by the Acts of 1882 and 1888, which also safeguard the interests of the citizens in other directions, it is not desirable that the Council should take steps to obtain a provisional order until it has ascertained what arrangements can be made with the existing Electric Light Company for the optional purchase by the Council of their works at shorter specified periods than 42 years." He reiterated a statement which he had previously made, that if the Authority obtained the necessary powers from the Board of Trade it would cost them £30,000. Mr. Pope seconded the amendment, which, after a discussion, was adopted by 28 votes to 13. A small committee was appointed to confer with the Electric Light Company and go into all matters of detail.

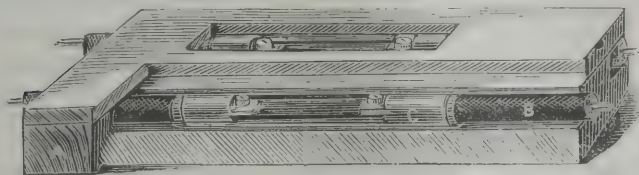
**Electric Lighting in Chelsea.**—The figures given by the surveyor in the vestry's annual report and published by us are rather ancient. The houses taking current have increased to 180, and, including those in South Kensington, represent 17,300 candle-power.

**Electric Lighting in Leeds.**—At a meeting of the Leeds County Council, on Monday, it was decided to leave the lighting of the Borough to private enterprise.

**Exhibition at Palermo.**—It is announced that a national exhibition will be held at Palermo during the coming year. The committee has determined to make the electrical portion of the exhibits a feature of much greater importance than was the case in the exhibitions at Turin and Milan.

**The Proposed Spanish Cables.**—The issue of *Industries* for the 3rd October contains the following note with regard to the telegraph cables to the African coast:—"Two tenders have been sent in to the Spanish Government for the laying of the cables from the coast of Spain to the African possessions in Morocco. One of the tenders is from the India-Rubber, Gutta Percha, and Telegraph Company, London, and the other from the Spanish National Company. Neither of the tenders agreed strictly with the bases that were required by the Government, and it seems likely that they will be rejected. The administration would have preferred to receive a tender from Messrs. Siemens, but this firm would not have agreed to such risky conditions as the Government demanded. The fact is that the cables to the other side of the Strait have a bad history." Our contemporary would have added considerably to the interest with which this note will be received had some authority for the last paragraph been given. The history of cables across the Strait would be a valuable addition to the records of submarine telegraphy.

**The Champion Cut-out.**—Under this name, Mr. J. Torr Todman is making a cut-out which can be placed in the ordinary wood casing which covers the cable, thus avoiding the necessity for cut-outs projecting from the walls. In the figure, A is the wood casing, B the cable, C the cut-out, consisting of two brass ends in



which the cable is soldered. These two ends are joined by a strip of vulcanised fibre, and the fuse wire is fixed under the two screws shown. The fuse and connection is covered by a glass tube which slides along the cable when it is necessary to renew the fuse.

#### Recent Interruptions and Repairs to Submarine Cables and Land Lines:—

	Interrupted.	Repaired.
Cable :—Jamaica—Colon...	16 July, 1890.	4 Sept., 1890.
Amoy—Shanghai	21 " "	3 Aug., "
Buenaventura—		
Santa Elena ...	30 Aug. "	7 Sept. "
Suez—Suakim ...	12 Sept. "	13 " "
Suakim—Perim ...	12 " "	Still interrupted.
Land Line :—Buenaventura	10 Sept. "	13 Sept., 1890.
Moulmein—Bangkok ...	14 " "	16 Sept. "

**The Proposed Electric Tramways in Glasgow.**—On Monday, September 29th, a deputation from the Glasgow Corporation, consisting of Bailie Paton (convener of general committee), Bailie Wallace (sub-convener of general committee), Bailie McFarlane, John Ure, Dean of Guild, and ex-Lord Provost, Councillor Colquhoun, and Mr. David Rankine, engineer, Glasgow Corporation Tramways, visited the General Electric Power and Traction Company's electric cars and installation on the Barking Road section of the North Metropolitan Tramways Company's system. The deputation were met by Messrs. Fuller and Macpherson, directors of the Electric Power Company, and by several of its leading officials. Having made a minute inspection of the many points of interest in the working of the cars, the corporation authorities expressed themselves as greatly pleased with all they had seen. The *raison d'être* of the visit was, that the Glasgow Corporation have it in view to take into their own hands, at the expiration of the present concession, the entire Glasgow tramway service, and equipping the same with accumulator cars. On the following day the deputation visited the installation of the Central Birmingham Tramway Company.

**Another Fatal Shock.**—A telegram from New York, dated October 5th, states that a man was killed in New Orleans the preceding day through coming in contact with an electric light wire.

**Account of a Cable Expedition.**—The October number of *Scribner's Magazine* contains an account, written by Mr. Herbert Webb, of the laying of the cables connecting Spain with the Canary Islands. It was scarcely necessary to disguise the names of the vessels employed, since the names of the islands, to which the cables were laid, are given. This, however, is but a minor consideration, and in no way detracts from the merits of the article in question. Some of the difficulties met with in cable work are well described, and we may congratulate Mr. H. Webb on having written a popular account of some of the incidents connected with submarine telegraphy. The article is sufficiently well illustrated.

**The Advantages of Technical Education.**—The students of the Glasgow and West of Scotland Technical College appear to be doing well, especially in the engineering classes under Prof. A. Jamieson. Mr. James Raeburn, who attended the electrical engineering laboratory, has been despatched to St. Petersburg to settle details about the electric lighting of Odessa Harbour, the Russian Government having approved of his plans prepared for the Thomson-Houston Company, who are giving him £500 per annum. Mr. Arthur H. Allen, who gained first-class honours in both electricity and electric lighting last session, has entered the service of Messrs. Holmes and Company, of Newcastle; and Mr. Auchinachie, from Keith, has been given a good appointment with the well-known firm of Messrs. Siemens Brothers & Co., of London and Charlton.

**O. S. A. Annual Dinner.**—The sixth annual dinner of the Old Students' Association of the City Guilds of London Institute will be held at the Holborn Restaurant on Friday, October 17th, 1890, at 7 p.m. Tickets, price 4s. 6d. each, may be obtained from the secretary, 14, Garfield Road, Lavender Hill. Mr. W. B. Esson is the president of the Association for the ensuing session.

**The Postmaster-General and the Case of Senior Telegraphists.**—The following notice was posted in the Central Telegraph Department on Saturday last. "In continuation of the notice of the 14th July, the Postmaster-General desires to notify that, with the consent of the Lords of the Treasury, he has converted 43 of the existing senior telegraphists appointments on the male staff into a new body of second class assistant superintendents on a scale of £200, rising, by £10 annually, to £260. The minimum of the senior class of telegraphists will be £160 per annum." Twenty corresponding appointments will be made on the female staff. Curiously enough, these new appointments are dated Sunday, October 5th, and this very unusual circumstance has given rise to much speculation and conjecture.

**The School of Electrical Engineering and Submarine Telegraphy.**—As the result of the examinations recently held at the above school, we are informed that the following gentlemen have now obtained the Vellum Certificate of the school:—(a) In electric lighting and power transmission—Messrs. Claypoole, Garré, Gillies, Lawrence, Phillips, Roussel and Waring. The examinations in these subjects were conducted by Mr. Gisbert Kapp, and included a *viva voce* and practical examination. (b) In telegraphy and telephony—Messrs. Lawrence (above named) and Salmony. This examination was conducted by Mr. H. R. Kempe.

**Movements of Cable Ships.**—On the morning of Wednesday, October 8th, the s.s. *Silvertown* left the Silvertown Company's works, en route for the West Coast of America, to lay direct cables between Lima, Yquique, and Valparaiso.

H.M. telegraph ship *Monarch* sailed for the Irish Channel to repair one of the Post-office cables.

The s.s. *John Pender* left the river for, we are informed, the Red Sea, to relieve the cable steamer at present stationed there.

**The Manchester Association of Engineers.**—We notice in the syllabus of the 1890-91 season of the Manchester Association of Engineers that on January 24th next, Mr. A. B. Blackburne, assistant manager to Messrs. Mather and Platt's electrical department, is announced to read a paper on "Dynamos: the Consideration of the Chief features which Regulate their Application." We hope that Mr. Blackburne's latest experiences will enable him to put before his audience something new; in any case, his discourse is certain to prove interesting.

**Anticosti Cable.**—Messrs. W. T. Henley's Telegraph Works Company, Limited, write to us as follows:—"Referring to the paragraph under this heading in your "Notes" in the issue of the 3rd inst., we beg to inform you that this cable was made by us, the core being composed of our patent ozokerited vulcanised India-rubber, of which the Canadian Government have had considerable experience for some years past."

**A Gallant Deed.**—IN the REVIEW for September 19th, we chronicled the death of lineman Kepp, in New York, but there was an incident connected with this matter which has only just come to our notice through the columns of *Modern Light and Heat*, and which we have much pleasure in bringing before our readers. Our contemporary says:—"The electric lineman must beware of the live wire. If he is possessed of ordinary intelligence and presence of mind, and is thoroughly instructed in the duties and requirements of his calling, as every lineman should be, any accident which may befall him must be the result of his own negligence or hardihood. The death of lineman Kepp, and the gallant but too late rescue of the suffering man by Mr. Charles Phipps, of the Brush Company, illustrate this. Had the unfortunate lineman taken the ordinary precaution of using rubber gloves, he would have been alive to-day. Mr. Phipps's heroic act was fraught with much greater danger than that which menaced the lineman. He was coming out of the theatre in evening dress, and with rare presence of mind took in the whole situation at a glance. He had no rubber gloves, but he improvised a substitute with rubber coats borrowed from hackmen. Thus protected, he climbed the pole and cut the wire across which the lineman hung, after which he lowered the man into the arms of those who were waiting and watching below. Although Mr. Phipps made light of his brave action, those who saw it were more appreciative, and we believe that the gold medal of the Humane Society has been awarded to many not more deserving than the noble-hearted electrician."

**Opening for Electric Traction.**—Colonel C. M. Davidson, the chairman of the Hawaiian Tramways Company, stated at the meeting of the company last week that the "board were doing their best to keep down the expenses of the company, and with that view they were considering the advisability of running their tramway by electricity." English traction companies should attend to this.

**The National Telephone Company.**—We hear that the directors of the National Telephone Company, Limited, have decided to reduce their rates of £15 to £10 per annum, and that they are further considering the question of giving special advantages to their subscribers for trunk line service.

**Dublin City Lighting.**—The time for receiving tenders has been extended to the 30th October.

**Killarney in the Running.**—The Town Commissioners, after various flights of oratory, have again settled on the earth, and will apply for a provisional order in a reasonable manner.

**Electric Light at Gravesend.**—After many discussions the Town Council has resolved to apply for a provisional order.

**Electric Traction.**—At the usual meeting of the Oswaldtwistle (Lancashire) Local Board, on Monday, consent was given to Mr. Chadwick, C.E., constructing an electric tramway through that township to Accrington on satisfactory terms being arranged.

**Personal.**—Last week the electrical engineering pupils of Messrs. Immisch & Co., Kentish Town, presented a piece of silver plate, as a token of their esteem, to Mr. Charles Francis Quicke, late chief engineer and works manager, on his relinquishing that post, after eight years' connection with the firm. The workmen and staff also presented, on their own behalf, a massive silver spirit case and an inlaid cabinet.

Mr. G. Jones, electrical engineer at Chatham Dockyard, has been ordered to proceed to the works of the Naval Construction and Armament Company, Barrow-in-Furness, to assist Mr. Apsey, who recently proceeded from this yard to superintend the construction of the electric light apparatus which is being manufactured for vessels of the Royal Navy.

**Electric Light Accidents.**—A correspondent of the *Times* says an engineer in the electric light works at Waltham, in Massachusetts, last Thursday received an electric shock of 1,500 volts. His hands were badly burnt, but his injuries were otherwise not serious. Although he was, perhaps, working a 1,500-volt circuit, it does not follow that a current passed through him at that difference of potential,

**A Correction.**—A correspondent says our note last week, on "A Telegraph Superintendent Killed," was exaggerated; the man is still dead.

**Edinburgh Exhibition.**—At a committee meeting held last week in the City of London, it was resolved to consider the exhibition a success. Over three million people have passed the turnstiles, a fact which is probably due to the near vicinity of the Forth Bridge.

**The Revolution in Copper.**—On Thursday, the 25th September, Dr. John Hopkinson paid a visit to the works of Elmore's Patent Copper Depositing Company, at Leeds. His time was limited, so his report simply states that he had an opportunity of observing the effect of the burnishing tool upon the deposited copper which, under its influence, exhibited a beautifully smooth surface. He also confirms his previously expressed opinion that on a large scale the Elmore process of depositing should not exceed £5 a ton or  $\frac{1}{2}$ d. per lb., and he returned well satisfied with what he saw. A report from Dr. Hopkinson, or any other qualified expert, giving a comparison of the actual cost of the Elmore and other processes for producing copper tubes would have been to the point, and have put us in possession of hard facts instead of estimated data with which we have hitherto had to content ourselves.

**The Channel Telephone Cable.**—We understand that Messrs. Siemens Bros. & Co. have secured the contract for manufacturing the 4-cored cable to be used for telephoning across the Channel. -

**Woodhouse and Rawson United, Limited.**—The report and balance sheet of this company is before our readers, and the meeting to discuss the same takes place to-day. It would, of course, be very interesting to know how the gross profit of nearly £100,000 was made, how much from trading, and how much from company promoting. The shareholders, however, will doubtless be content with their 15 per cent., and we sincerely trust that so good a dividend will be always forthcoming.

**Edinburgh and the Electric Light.**—At a meeting of the Edinburgh Town Council on Tuesday, it was resolved, on the motion of the Lord Provost, to make application to the Board of Trade for a provisional order.

**The Nicaragua Canal and the Telegraph.**—In connection with the works on the Nicaragua Canal, which are stated to be progressing most favourably, we learn that a telegraph line has been completed between Greytown and the Lake of Nicaragua, where a junction is made with the telegraph lines to the Pacific Coast. We therefore presume that telegraphic communication is now established between Greytown and the United States *via* the Central and South American Company's cables which touch at San Juan del Sur, a port on the Nicaraguan coast, and connected by Government lines with the principal towns in that Republic.

**Berliner's Gramophone.**—Several gramophones of this make have, during the past three weeks, been shown in operation at 11, Queen Victoria Street, E.C. It is not unlikely that we may hear more of this invention shortly from a company point of view.

**Electric Railway Experiments.**—Some experiments have been made with a railway waggon fitted with motors and accumulators, on the local railway Hildburghausen-Heldberg-Friedrichshall, in Bavaria. The line is about 19 miles long, and the waggon is said to have worked successfully. This is the greatest test with electric traction in Germany. The experiments were made by the builder of the railway, Mr. Hostmann and two other engineers, one being from the Oerlikon Engineering Works.

**The Report of the Postmaster-General.**—The report of the Postmaster-General, issued last week, shows a great increase of business. Telegraphic money orders issued during the month of March amount to £6,262. In the course of the year 263 post-offices and 58 railway offices were opened for telegraphic business, making the total number of such offices open on the 31st March 5,673 and 1,679 respectively. The total number of telegrams dealt with was 62,403,399, as compared with 57,765,347 in the previous year.

## NEW COMPANIES REGISTERED.

**Leeds and London Electrical Engineering Company, Limited.**—Capital £100,000, divided into 250 founders' shares, 9,750 non-cumulative £7 per cent. preference shares, and 10,000 ordinary shares of £5 each. Objects: To form centres in the United Kingdom and elsewhere at which electrical energy may be generated and accumulated, and from which the same may be distributed for public and private lighting of every description, or for supplying motive power or heat, and to enter into contracts for such purposes. To acquire the right to manufacture and put up telephones, telegraphs, electric bells, phonographs, and all other electrical apparatus now known or hereafter to be invented. To manufacture lightning conductors, electrical generators, motors, cables, accumulators, lamps, and fittings of all kinds. Signatories (with 1 share each): H. Linklater, 5, Benthall Road, N.; T. B. Arundell, 1, Devonshire Street, Portland Place; P. H. Clark, 51, Norroy Road, Putney; James Whitehead (electrical engineer), Heycot, Crouch End, N.; J. A. Roxburgh, 77, Queen's Road, Finsbury Park; J. Kerby Chambers (electrical engineer), 10, Richmond Villas, Holloway; J. W. S. Hawes, 25, Colebrooke Row, N. The signatories are to appoint the first directors; qualification, £500 in shares; remuneration, one-tenth of the net profits after payment of 7 per cent. dividend on preference and ordinary shares, provided that the maximum remuneration be £1,500 per annum. Registered 2nd inst. by Wilson & Co., 1, Copthall Buildings.

**Electro-Metallurgical Company, Limited.**—Capital £2,500, in £5 shares. Objects: To acquire the business of electro-metallurgists, platers and depositors on metals, carried on by the Electro-Metallurgical Company at 23, Newhall-street, Birmingham, and the business of electro-platers carried on by the Victoria Plating Company at 9 and 10, Sherborne Road, Balsall

Heath, Birmingham. Signatories (with 1 share each): \*Alfred Smallwood, \*Alfred Gough, \*H. Fenney, Wm. Ralph Bradley, J. J. Bedney Arter, J. H. Fenney, E. G. Walters, all of Birmingham. The signatories denoted by an asterisk are the first directors. Registered 3rd inst. by T. H. Philpots, 89, Chancery Lane, agent for Alfred Gough, 120, Edmund-street, Birmingham.

**Buller's, Limited.**—Capital £200,000, in £10 shares. Objects: To acquire the business and liabilities of Buller, Jobson & Co., Limited (in voluntary liquidation), engineers and contractors. To manufacture and produce electrical plant, and to supply electric and other forms of power and energy. Signatories (with 1 share each): \*E. W. Buller, 49, Charlotte Road, Birmingham; \*H. C. Jobson, Kidderminster; E. J. Chambers, Dudley; W. Greenhill, Dudley; E. P. Jobson, Dudley; A. T. Buller, Penrith; J. T. Harris, Stone, Staffordshire. The first two signatories are appointed directors; qualification, 100 shares. Registered 6th inst. by Waterlow Brothers and Layton, Limited, agents for Smith, Pinsent and Co., of Birmingham.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

### Patent Lithographic Zinc Plate Company, Limited.

—The statutory return of this company, made up to the 20th August, was filed 6th September. The nominal capital is £10,000 in £5 shares; 700 shares are taken up, 200 being considered fully paid. Upon 500 shares £3 per share has been called and paid. Registered office, India Chambers, Queen's Dock Side, Hull.

**J. A. Egestorff and Company, Limited** (manufacturers of ultramarine and colours and electrical engineers).—The statutory return of this company, made up to the 29th August, was filed September 4th. The nominal capital is £10,000 in £5 shares; 1,290 shares have been taken up, 400 being considered fully paid. Upon 890 shares, £2 10s. per share has been called, the calls paid amounting to £1,509 10s., and unpaid to £715 10s. Registered office, Backbarrow, near Ulverston.

**Buller, Jobson and Company, Limited.**—At an extraordinary general meeting of the members of this company, held at the Great Western Hotel, Birmingham, on 16th ult., it was resolved to wind up voluntarily, the liquidator, Mr. W. Newton Fisher, of Waterloo Street, Birmingham, chartered accountant, being authorised to enter into an agreement with a new company to be called Buller's, Limited, for the transfer to that company of the assets and liabilities of this company. These resolutions were confirmed on the 2nd inst. and were duly filed on the 3rd inst.

The last return of the company is made up to the 10th February; the nominal capital at that date was £108,100 divided into 5,405 "A" and 900 "B" shares of £20 each. 4,505 "A" and 900 "B" shares have been taken up and the full amount has been called thereupon. Upon 4,497 "A" and 900 "B" shares the full amount is considered as paid up. The calls paid amount to £160. At a meeting of the company, held on the 7th March, the capital of the company was increased by the sum of £50,000, divided into 2,500 first preference shares of £20 each, carrying a cumulative dividend of 6 per cent per annum.

**Kent Patent Arc Lamp Company, Limited.**—The subscribers to this company have appointed as directors of the company Mr. Herman Stanberg, of 45, High Street, Borough, S.E., and Richard Dyson, of 15, Australian Avenue, E.C. The registered office of the company is now situated at 17, Holborn Viaduct. Secretary, Mr. Arthur Salter.

**Baxter's, Limited** (civil, marine and electrical engineers).—The statutory return of this company, made up to the 29th July, was filed 23rd August. The nominal capital is £30,000, divided into 1,000 preference and 5,000 ordinary shares of £5 each. 14 ordi-

many shares are taken up, and £4 has been called and paid thereon, the calls paid amounting to £56. Registered office, Sandiacre, Derby.

**Peru Telephone Company, Limited.**—The registered office of this company is now situate at 42, Old Broad Street, E.C.

**Ecuador Telephone Company, Limited.**—The registered office of this company is now situate at 42, Old Broad Street, E.C.

## CITY NOTES, REPORTS, MEETINGS, &c.

### Woodhouse and Rawson United, Limited.

THE annual report of the directors to be laid before the meeting at Winchester House to-day (Friday), the 10th inst., states:—Of the original capital all the ordinary and preference shares have now been issued. Of the ordinary shares, one-half of their value remains uncalled. The premiums from the second issue, amounting to £4,050 5s. have been placed to a reserve fund. From the balance sheet it will be seen that after payment of all expenses and writing off £7,421 16s. 9d. in reduction of the sum standing to patent account, the balance to the credit of the company amounts to £61,085 1s. 9d. Out of this sum the directors propose to pay a dividend at the rate of 15 per cent. per annum on the ordinary shares and of 8 per cent. per annum on the preference shares, which, together with the interim dividend for the half-year already paid at these rates, amounts to £18,749 6s. 6d. Of the balance, amounting to £42,335 15s. 3d., the directors propose to place to reserve £25,000, of which £10,000 will be set aside to a goodwill reserve fund, and £15,000 to a general reserve fund, and to apply £1,000 to the formation of an *employés* pension fund, leaving £16,335 15s. 3d. to be carried forward to next year's account. The directors do not propose to increase the dividend anticipated in the prospectus, as the prudence of building up reserve funds of a considerable amount will be evident to the shareholders.

The directors think it well on this occasion to give more information than is usually contained in an annual report, in order to enable the shareholders to realise the scope and extent of the operations in which the company is engaged. Their efforts during the past year have been directed to consolidating and extending the several branches of business which have been taken over by the company. These are of a very comprehensive character, and include:—

1. The manufacture of all articles connected with electricity and engineering, so far as they come reasonably within the technical and financial resources of the company.

2. The supply of all articles connected with electricity and electrical engineering.

3. The execution of all works of installation coming within the province of electrical engineers and contractors.

4. The testing and proving of new patents and inventions connected with electrical and engineering science, and their introduction to the public, either by arrangements for working such inventions by this company or by assisting the owners in forming separate companies for working them.

The experience of the past year leaves no doubt that great services may be rendered to the shareholders and to the public by developing this latter branch of the business, with prudence and energy; and the knowledge acquired from an extensive range of manufactures, and a thorough acquaintance with the demand and channels of supply of electrical plant and apparatus, place this company in an exceptional position to invite and secure the confidence of inventors, and to assist them in bringing their inventions before the public. With this object it is necessary to command the ready means of practically testing every kind of electrical and mechanical invention which may be offered, and to maintain an extensive business and correspondence in all parts of the world.

The following are the factories owned by the company and the character of the work done:—

a. West Kensington Hall Works, Hammersmith Road, W. These works, over an acre in extent, are the company's freehold. Here are manufactured light goods, such as switches, lamps, measuring and other electrical instruments, primary and secondary batteries, and every class of small automatic machinery. Here also is carried on the electro-plating business and manufacture of plating plant. At these works most processes offered to the company are tested, and only when they have thoroughly passed the examination of the company's experts is the purchase or introduction to the public entertained. At the present moment four important electrical inventions of exceptional merit are undergoing the process of final testing.

b. Union Foundry, Kidsgrove, near Crewe. These works, which are also freehold, have been recently acquired on advantageous terms, and are well situated in the heart of the coal and iron district, having both a railway siding and a canal adjoining. They are fitted up with every class of heavy machinery to enable the company to construct engines and boilers of almost any size or power, water and gas works plant, steam and hydraulic cranes, tanks, pumps, large dynamos and other heavy machinery, whilst

further special plant is now being erected to keep abreast of recent improvements.

c. Cornbrook Telegraph Works, Manchester. These works are leasehold, and are fully engaged in the manufacture of telegraphic instruments; there are also manufactured small dynamos and motors, as well as light lathes and drilling, shaping, milling and screwing machines, specially designed for electrical work. Practically the whole of the contracts for telegraphic instruments, &c., for the London and North Western Railway for a period of two years, together with contracts for the Caledonian and Great Eastern Railway Companies, have been placed with the company at these works.

d. The supply department is rapidly increasing its turnover. Its catalogue of electrical goods and appliances connected therewith is recognised as the most complete and comprehensive of its kind, and forms a standard text book in the trade. The acquisition of the new warehouse, with entrance at 30, Cannon Street, and more recently of the lease of the neighbouring premises at 34, Cannon Street, and 84, Queen Victoria Street, enables the company to keep in hand and exhibit an extensive stock of nearly every kind of electrical apparatus and fittings.

e. The installation department has carried out a large number of important contracts. Among others, the lighting of the palace at Mysore, India, by electricity has been satisfactorily and profitably finished; and the Sociedad Española del Electricidad, in Barcelona, has placed the whole of their arrangements for improving and extending the lighting of that city by electricity in the hands of this company.

f. At Bradford the company have a branch establishment, with show room and warehouse, which provides for installations and the supply of electrical goods in the North of England. The company has been specially appointed contractors to the local authorities in that town in connection with their central electric lighting station.

g. An electric bell and signalling business is conducted at 2, Gray's Inn Road, under the management of the Messrs. Jensen, whose well-known patents this company has acquired.

h. The company has also acquired the electric and steam launch business of Mr. Sargeant, carried on at Chiswick.

Branch offices have been opened during the year in Sydney, Melbourne, Johannesburg, and Valparaiso, besides additional agencies in various other foreign countries. In the early part of the present year the directors disposed of a portion of their premises at West Kensington to the Kensington Co-operative Stores, Limited, a new company, which obtained the support of this company because it afforded an opportunity of disposing, upon advantageous terms, of a portion of its buildings unsuitable for manufacturing purposes, and increased the value of the remainder of the property. A second issue of shares of the Kensington stores has lately been made at a large premium, and was applied for two and a half times over. The directors have, in addition, been instrumental in forming the International Okonite Company, for the working throughout the world of the patents for that valuable insulating material. The company, whose shares have been entirely allotted, has an established business in America of a profitable and rapidly increasing character, and owns works also at Manchester, from which it will supply the okonite wire required in Great Britain. The yield of both the American and English works during the current year has largely increased, and a profitable return may be looked for. This report would not be complete without an allusion to the success that has attended the introduction by Woodhouse and Rawson, Limited, of the now well-known Elmore process for manufacturing copper articles by electro-deposition at a great saving of cost, and of unique quality. Since the expiration of the financial year ending on the 30th June, 1890, this company has introduced Elmore's French Patent Copper Depositing Company with very marked success; 66,750 shares were offered for subscription, and over 250,000 shares were applied for. The official quotation of the shares of this company in the Stock Exchange list is now before the committee. Owing to the delay in the winding-up of the vendor companies, mainly caused by the protracted arbitration in which one of them was engaged at the time of purchase, a final settlement with them had not been effected before the close of the first financial year of this company. These difficulties have since been removed, and the directors daily expect to have the quotation granted. The sum of £75,000 which, as stated in the prospectus, Woodhouse and Rawson, Limited, was to lodge with this company as a guarantee fund for the payment of a minimum dividend of 15 per cent. per annum for the first three years, has been duly received.

The shareholders will doubtless approve of the formation of an *employés* pension fund, which will tend to the retention of those employed by the company, by requiring faithful services when age, failing health, or other causes necessitate their temporary or permanent withdrawal from the company's employ. The amount proposed to be placed to the credit of this fund, though comparatively small for the purpose intended, will form a nucleus to which in future, as the company's success is consolidated, larger sums may be allocated. A resolution to give effect to this proposal will be submitted to the meeting. The directors feel that the shareholders owe a great deal to the various members of the staff for devoted services rendered, regardless of personal comfort and hours of labour, and especially to the managing director, Mr. F. L. Rawson, to whose zeal, enterprise and judgment the results obtained in this the first year of the company's operations are mainly due. By the articles of association two directors retire. The two who retire are Lord Aberdare and Sir Rawson W. Rawson; the latter, being eligible, offers himself for re-election; the

former from impaired health and enforced absence from London, does not offer himself for re-election. In his place the directors propose, with the approval of the shareholders, to elect the Right Hon. Sir Edward Thornton, G.C.B. The auditors, Messrs. Pixley and Co., retire according to the articles, and offer themselves for re-election. In conclusion the directors congratulate the shareholders on the position and prospects of the company.

### The International Okonite Company, Limited.

Mr. SAMUEL POPE, Q.C., presided at the statutory meeting held at the Cannon Street Hotel yesterday, and after explaining the object of statutory meetings, went on to say that the company's articles of association provided that the first general meeting should be held within the statutory period of four months. The board, therefore, thought it desirable not to treat this meeting as a purely statutory one, but that the directors should meet the desire of many of the shareholders by stating exactly what had been done since they came into office, and the prospects of future development. The company's capital had originally been fixed at £440,000, divided into £170,000 of £10 preference shares, £170,000 of £10 ordinary, and £100,000 of £100 debentures. Of that amount, £113,330 had been paid to the vendors as founders' shares, as well as £33,300 of debentures. That left £226,670 of preference and ordinary shares to be allotted to the various applicants. Of that £226,670, the whole had been fully subscribed, without a single share having been underwritten. Of the debentures, out of £66,600 (the balance of the £100,000, after deducting the £33,300 to be allotted to the vendors), £51,100 had been taken up, leaving a balance of £15,000, the only balance unallotted of the entire capital, which it was the directors' intention not to allot until they required the money. The company's capital account was therefore summed up in the description that "the whole of the capital has been subscribed for and allotted," with the exception of £15,000 worth of debentures which they did not require to allot. The company's managing director and Mr. Connolly, the works manager, had visited the United States since the company's incorporation for the purpose of examining into the business and working of the factory at Passaic, New Jersey, and the special processes carried on there for the purpose of working similar plant at the company's Manchester works. The managing director had returned, Mr. Connolly was on his way home. The former reported, and the speaker believed Mr. Connolly agreed with him, that the works were in first class order, well organised, admirably arranged and fully occupied. Assuming the turn-out for 1887 as the unit 100, then the turn-out in 1888 represented 164; in 1889, 224; and in 1890, so far, the satisfactory figure of 450. In other words, the investigation had shown that the output at the American works had become four-and-a-half times what it was in 1887. In addition to the founders' shares named in the prospectus, the directors who formed the American committee had subscribed for considerably over £60,000 in shares, and paid for them in the ordinary way. The title to the American factory had been thoroughly examined and approved by the solicitors, Messrs. Davies, Short and Townsend, of New York. The whole of the purchase money had been paid, and the property in America had been invested in the Central Trust Company of New York, as trustees for the debenture holders. From personal inspection the company's managers reported themselves satisfied that the business was a sound and lucrative one with every prospect of a large and continuous increase; and that there was an immense advantage in having a factory both at New York and Manchester. With regard to the Manchester works, the business had been taken over and paid for, and the company had since acquired a plot of vacant land of about an acre, bounded on one side by the company's own factory, on another by the Rochdale Canal, and on the other two sides by good roads. On this they were actively working an improved fireproof factory for the manufacture of the company's specialité of high-class okonite wires and cables, and the necessary machinery was well in hand. The works were in full swing manufacturing the various classes of insulated wires, and orders were coming in most satisfactorily. Messrs. Shaw and Connolly had agreed to serve the company for a term of years, and, as both gentlemen had technical and business knowledge second to none in the manufacture of insulated wire, the directors had every reason to anticipate that, with the capital at their command, the English business would soon rival, if it did not exceed, the American. Certain statements as to the profits of the year had been made in the prospectus, and some shareholders had questioned the profits for 1889 and 1890 of Shaw and Connolly (which, the meeting would remember, had been taken as estimated, and not as ascertained), and also the profits of 1890 of the old Okonite Company, these profits not having been ascertained by a competent accountant at the date of the prospectus. However, the directors were now in possession of Messrs. Price and Waterhouse's report and statement, which showed the statements in the prospectus to be well under the actually ascertained amount. With regard, however, to the profits of 1890 of the old company in America, the directors had not yet received Messrs. Price and Waterhouse's certificate. The directors had cabled to New York for the most recent information as to the progress of the audit, for of course it was desirable to know as far as possible the actual facts with regard to the property acquired; and they had received from the New York office, under date September 26th, a letter which stated that the books were not quite closed, but that approximately it

was thought that the profits would be considerably larger than the prospectus claimed they would be. The actual result had since been cabled for, but the directors had not yet received the certificate. However, from what the general manager said, he (the speaker) did not doubt that the statements referred to would be abundantly justified by the facts. Of course the directors could have no great experience in the management of the concern during that short period in office, but he thought he might say that the view which his colleagues, and which he himself would desire to see carried out, would be to manage the concern with an eye to making it a substantial commercial undertaking, and not with a view merely to create a temporary fictitious value in the shares of the company. During the last three years of the Okonite Company's working they had never had returned to them a single yard of okonite wire as being of defective insulation. The whole of the wires were guaranteed to a standard far in excess of the working requirements, and were fully tested 100 per cent. over the company's guarantee before leaving the works. The same system would be adopted in England, as, although it tended to slightly increase the cost of production, it was important that their electrical insulated conductors should be of a high class, and absolutely reliable. The scrip certificates had been issued, and application had been made to the Stock Exchange for a special settlement and quotation in the official list. As showing how active the English business of the company was, the speaker produced an order from an English firm for 135,000 feet of okonite wire.

After several shareholders had expressed their satisfaction with the statements just made, an extraordinary general meeting was held, as announced, and the following resolution, which, the chairman explained, was intended to make certain minor alterations in the articles of association, which had been called for by the Stock Exchange, was passed, and the proceedings terminated.

**Resolution.**—"That the articles of association of the company be altered in the following manner:—

"(a) In clause 35, that the portion of the clause following the words 'provided that' be struck out and the following inserted: 'The funds of the company shall not be expended in the purchase of or lent upon the security of its own shares.'

"(b) In clause 72, that the following words be added at the end of the clause: 'And, unless he shall do so, he shall be deemed to have agreed to take the said shares from the company, and the same shall be forthwith allotted to him accordingly.'

"(c) In clause 116, that the following words be added at the end of the clause: 'And a copy of such balance sheet shall be posted to each member at his registered address at least eight days before such ordinary general meeting.'"

### Brazilian Submarine Telegraph Company, Limited.

—The accounts, subject to audit, show a profit sufficient to enable the directors to recommend a final dividend of 3s. per share, making, with previous distributions, a total dividend of 6 per cent. for the year ended 30th June, 1890, and also the payment of a bonus of 3s. per share, both free of income tax, which, together, will amount to £39,000, being a distribution in the aggregate of 7½ per cent. for the past year, leaving a balance of £42,416 18s. 1d., of which amount £40,000 has been placed to the reserve fund, increasing that fund to £352,626 2s. 11d., and £2,416 16s. 1d. carried forward.

**A Franco-Russian Company** is about to organise a new telegraphic agency in Servia and the other Balkan countries, the Servian Government having declined to renew its connection with the Vienna Correspondence Bureau.

**The Telephone Company of Austria, Limited**, notifies that the usual half-yearly dividend to the 30th ult. on the preference shares, at the rate of 6 per cent. per annum, has been declared by the board.

**Reuter's Telegram Company, Limited.**—The directors have declared an interim dividend at the rate of 5 per cent. per annum, free of income tax, for the half year ending the 30th June last.

### TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending October 3rd, were £5,323.

The Cuba Submarine Telegraph Company, Limited. The receipts for the month of September were £3,000, as compared with £2,372 in the corresponding month of last year. The receipts for the month of June, estimated at £3,500, realised £3,324.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of September were £2,526, against £2,159 in the corresponding period of last year.

The Great Northern Telegraph Company, Limited. The receipts for the month of September amounted to £25,500; 1st January—30th September 1890, £108,600; corresponding months 1889, £208,200; do. 1888, £202,900.

West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended September 30th, show an increase of £187 as compared with the corresponding period.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 3rd, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,163.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (October 2).	Closing Quotation. (October 3).	Business done during week ending October 3, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98—101	98—101		
1,549,160	Anglo-American Telegraph, Limited	Stock	51—52	50½—51½	51	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	87—88	87—88	88½	87
2,725,420	Do. do. Deferred	Stock	14½—14¾	14½—14¾	14½	14½
130,000	Brazilian Submarine Telegraph, Limited	10	11½—12½	11½—12½	12½	11½
99,000	Do. do. 5 p. c. Bonds	100	100—102	100—102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103—107	103—107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½—2	1½—2		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½—2	1½—2		
7,216,000	Commercial Cable, Capital Stock	\$100	102—104 xd	102—104	103½	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	5½—5¾	5½—5¾		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½—5¾	5½—5¾		
16,000	Cuba Telegraph, Limited	10	11½—12½	11½—12½	11½	...
6,000	Do. do. 10 p. c. Preference	10	17—18	17—18		
12,931	Direct Spanish Telegraph, Limited (£4 only paid)	5	4—4½	4—4½		
6,000	Do. do. 10 p. c. Preference	5	9—10	9—10		
60,710	Direct United States Cable, Limited, 1877	20	10½—10¾	10½—10¾	10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14—14½	14—14½	14½	14
70,000	Do. do. 6 p. c. Preference	10	15—15½	15—15½	15½	...
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106—109	106—109	108	106½
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	104—107	104—107	105½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14½—14¾	14½—14¾	14½	14½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100—102	100—102		
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	101—101½	102—103		
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	101—101½	102—105	102½	...
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	101—104	101—104	102½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½—8½	7½—8½	7½	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½—5½	4½—5½		
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5—5½	5—5½	5½	5½
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid)	2	2½—2½	2½—2½	2½	2½
19,700	Fowler-Waring Cables, Nos. 301 to 20,000 (£3 only paid)	5	3½—4	3½—4		
180,227	Globe Telegraph and Trust, Limited	10	8½—9½	8½—9½	8½	...
180,042	Do. do. 6 p. c. Preference	10	14½—15	14½—15	15	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½—16½	15½—16½	16	15½
40,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	100—103	101—101½		
250,000	Do. do. do. do. (issue of 1883)	100	104—107	104—107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½—12½	11½—12½		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½—12½	11½—12½		
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½—19½	18—19	18½	18½
200,000	Do. do. 4½ p. c. Deb., 1896	100	100—102 xd	102—101	101½	...
17,000	Indo-European Telegraph, Limited	25	36—38	36—38	36½	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½—7½	6½—7½		
100,000	Do. do. do. 6 p. c. Debentures	100	105—108	105—108		
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	4—4½	5½—6½	5½	5½
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4½—4¾	4½—4¾	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½—12¾	12½—12¾	12½	12½
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10—10½	10—10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	4	8—8½	8—8½		
9,000	Reuter's, Limited	8	8½—8¾	8½—8¾		
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	1—...	1—...		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½—3	2½—3		
3,381	Submarine Cables Trust	Cert.	113—117	113—117		
78,949	Swan United Electric Light, Limited (£3½ only paid)	5	5½—5¾	5½—5¾	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	43—45	43—45	44½	43½
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100—102	100—102		
55,000	United River Plate Telephone, Limited	5	3½—4	3½—4		
146,000	Do. do. do. 5 p. c. Debenture Stock	Stock	90—94	90—91		
100,000	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	9—10	8—9		
300,000	Do. do. do. 5 p. c. Debentures	100	99—102	98—101	100½	99½
30,000	West Coast of America Telegraph, Limited	10	4½—5	4½—5		
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	102—107	102—107	103½	...
64,572	Western and Brazilian Telegraph, Limited	15	11½—11¾	11½—11¾	11½	11½
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½—7½	6½—7½	7	7½
26,986	Do. do. do. 5 p. c. Deferred	7½	4½—5½	4½—5½	4½	4½
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103—106	103—106		
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103—106	103—106		
88,321	West India and Panama Telegraph, Limited	10	3—3½	2½—3½	3½	2½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½—12	11½—12	11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	14—15	14—15		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	122—127	122—127		
179,300	Do. do. do. 6 p. c. Sterling Bonds	100	99—103	99—103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£2 only paid)	5	1—1½	1½—1½	1½	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7¾.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 1½—1½.—House-to-House Company (£5 paid), 5—5½.—International Okonite, Ordinary of £10 (£7 paid), 6½—7½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/-—13/-.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 407.)

HYSTERESIS.

I have already drawn attention to the difference between the ascending and descending curves of magnetisation, and may now point out that this is a part of a set of general phenomena of residual effects. The best known of these effects is, of course, the existence in some kinds of iron, and notably in steel, of a remanent or sub-permanent magnetisation after the magnetising force has been entirely removed. To this retardation of effects behind the causes that produce them the name of "hysteresis" has been given by Prof. Ewing. If a piece of iron is subjected to a magnetising force which increases to a maximum, then is decreased down to zero, then reversed and carried to a negative maximum, then decreased again to zero, and so carried round an entire cycle of magnetic operations, it is observed that the curves of magnetisation form a closed area similar in general to those shown in fig. 21. This closed area represents the work which has been

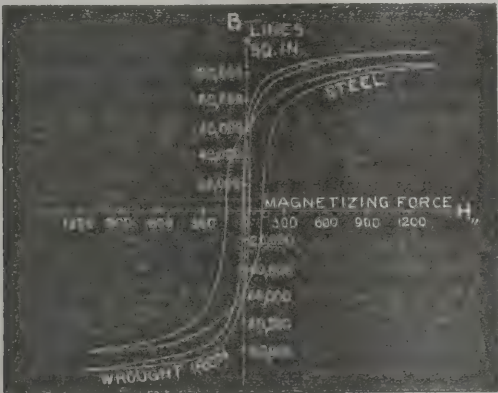


FIG. 21.—CURVES OF HYSTERESIS.

wasted or dissipated in subjecting the iron to these alternate magnetising forces. In very soft iron, where the ascending and descending curves are close together, the enclosed area is small; and, as a matter of fact, very little energy is dissipated in a cycle of magnetic operations. On the other hand, with hard iron, and particularly with steel, there is a great width between the curves, and there is great waste of energy. Hysteresis may be regarded as a sort of internal or molecular magnetic friction, by reason of which alternate magnetisations cause the iron to grow hot. Hence the importance of understanding this curious effect, in view of the construction of electromagnets that are to be used with rapidly alternating currents. The following figures of Table V. give the number of watts (1 watt =  $\frac{1}{746}$  of a horse-power) wasted by hysteresis in well-laminated soft wrought iron when subjected to a succession of rapid cycles of magnetisation:—

TABLE V.—WASTE OF POWER BY HYSTERESIS.

B	B <sub>r</sub>	Watts wasted per cubic foot at 10 cycles per second.	Watts wasted per cubic foot at 100 cycles per second.
4,000	25,800	40	400
5,000	32,250	57.5	575
6,000	38,700	75	750
7,000	45,150	92.5	925
8,000	51,600	111	1,110
10,000	64,500	156	1,560
12,000	77,400	206	2,060
14,000	90,300	262	2,620
16,000	103,200	324	3,240
17,000	109,650	394	3,940
18,000	116,100	487	4,870

It will be noted that the waste of energy increases as the magnetisation is pushed higher and higher in a disproportionate degree, the waste when B is 18,000 being six times that when B is 6,000. In the case of hard iron or of steel the heat waste would be far greater. Another kind of after effect was discovered by Ewing, and named by him "viscous hysteresis." This is the name given to the gradual creeping up of the magnetisation when a magnetic force is applied with absolute steadiness to a piece of iron. This

gradual creeping up may go on for half-an-hour or more and amount to several per cent. of the total magnetisation. Another important matter is that all such actions as hammering, rolling, twisting, and the like, impair the magnetic quality of annealed soft iron. Annealed wrought iron which has never been touched by a tool shows hardly any trace of residual magnetisation, even after the application of magnetic forces. But the touch of the file will at once spoil it. Sturgeon pointed out the great importance of this point. In the specification for tenders for instruments for the British Postal Telegraphs, it is laid down as a condition to be observed by the constructor, that the cores must not be filed after being annealed. The continual hammering of the armature of an electro-magnet against the poles may in time produce a similar effect.

FALLACIES AND FACTS ABOUT ELECTRO-MAGNETS.

I will conclude this lecture by stating a few of the fallacies that are current about electro-magnets and will add to them a few facts, some of which seem paradoxical. The refutation of the fallacies and the explanation of the facts will come in due course.

*Fallacies.*—The attraction of an electro-magnet for its armature varies inversely, as the square of its distance from the poles. The outer windings of an electro-magnet are necessarily less effective than those that are close to the iron.

Hollow iron cores are as good as solid cores of the same size. Pole pieces add to the lifting power of an electro-magnet. It hurts an electromagnet (or, for that matter, a steel magnet) to pull off the keeper suddenly. [It is the sudden slamming on that in reality hurts it.] The resistance of the coil of an electro-magnet ought to be equal to the resistance of the battery. A coil wound left-handedly magnetises a magnet differently from a coil wound right-handedly. [It is not a question of winding of coil but of circulation of current.] Thick-wire electro-magnets are less powerful than thin-wire electro-magnets. A badly insulated electro-magnet is more powerful than one that is well insulated. A square iron core is less powerful (as Dal Negro says, eighteen fold!) than a round core of equal weight. The attraction of an electro-magnet for its keeper is necessarily less strong (one-third according to Du Moncel) sideways than when the keeper is in front of the poles. Putting a tube of iron outside the coils of an electro-magnet makes it attract a distant armature more powerfully.

*Facts.*—A bar electro-magnet with a convex pole holds on tighter to a flat-ended armature than one with a flat pole does. A thin round disc of iron laid upon the flat round end of an electro-magnet (the pole end being slightly larger than the disc) the disc is not attracted, and will not stick on, even if laid down quite centrally. If a flat armature of iron be presented to the poles of a horse-shoe electro-magnet the attraction at a short distance is greater, if the armature is presented flankways, than if it is presented edgewise. On the contrary, the tractive force in contact is greater edgewise than flankways. Electro-magnets with long limbs are practically no better than those with short limbs for sticking on to masses of iron.

LECTURE II.—DELIVERED JANUARY 27TH, 1890.

General Principles of Design and Construction.—Principle of the Magnetic Circuit.

To-night we have to discuss the law of the magnetic circuit in its application to the electro-magnet, and in particular to dwell upon some experimental results which have been obtained from time to time by different authorities as to the relation between the construction of the various parts of an electro-magnet, and the effect of that construction on its performance. We have to deal not only with the size, section, length, and material of the iron cores, and of the armatures of iron, but we have to consider also the winding of the upper coil, and its form; and we have to speak in particular about the way in which the shaping of the core and of the armature affects the performance of the electro-magnet in acting on its armature, whether in contact or at a distance. But before we enter on the last more difficult part of the subject, we will deal solely and exclusively with the law of force of the magnet upon its armature when the two are in contact with one another; in other words, with the law of traction.

I alluded in a historical manner in my first lecture to the principle of the magnetic circuit, telling you how the idea had gradually grown up, perforce, from a consideration of the facts. The law of the magnetic circuit was, however, first thrown into shape in 1873 by Prof. Rowland, of Baltimore. He pointed out that if you consider any simple case, and find (as electricians do for the electric circuit) an expression for the magnetising force which tends to drive the magnetism round the circuit, and divide that by the resistance to magnetisation reckoned also all round the circuit, the quotient of those two gives you the total amount of flow or flux of magnetism. That is to say, one may calculate the quantity of magnetism that passes in that way round the magnetic circuit in exactly the same way as one calculates the strength of the electric current by the law of Ohm. Rowland, indeed, went a great deal further than this, for he applied this very calculation to the experiments made by Joule more than 30

\* Cantor Lecture. Delivered before the Society of Arts, January 20th, 1890.

years before, and from those experiments deduced the degree of magnetisation to which Joule had driven the iron of his magnets, and by inference obtained the amount of current that he had been causing to circulate. Now this law requires to be written out in a form that can be used for future calculation. To put it in words without any symbols, we must first reckon out from the number of turns of wire in the coil, and the number of amperes of current which circulates in them, the whole *magneto-motive force*—the whole of that which tends to drive magnetism along the piece of iron—for it is, in fact, proportional to the strength of the current, and the number of times it circulates. Next we must ascertain the resistance which the magnetic circuit offers to the passage of the magnetic lines. I here avowedly use Joule's own expression, which was afterwards adopted by Rowland, and, for short, so as to avoid having four words, we may simply call it the *magnetic resistance*. Mr. Heaviside has suggested as an advisable alternative term, *magnetic reluctance*, in order that we may not confuse the resistance to magnetism in the magnetic circuit with the resistance to the flow of current in an electric circuit. However, we need not quarrel about terms; magnetic reluctance is sufficiently expressive. Then having found these two, the quotient of them gives us a number representing—I must not call it the strength of the magnetic current—I will call it simply the quantity or number of magnetic lines which flow round the circuit; or if we could adopt a term which is used on the Continent, we might call it simply the *magnetic flux*: the flux of magnetism being the analogue of the flow of electricity in the electric law. The law of the magnetic circuit may then be stated as follows:—

$$\text{Magnetic flux} = \frac{\text{magneto-motive force}}{\text{reluctance}}.$$

However, it is more convenient to deal with these matters in symbols, and therefore the symbols which I use, and have long been using, ought to be explained to you. For the number of spirals in a winding I use the letter  $s$ ; for the strength of current, or number of amperes, the letter  $i$ ; for the length of a bar, or core, I am going to use the letter  $l$ ; for the area of cross section, the letter  $A$ ; for the permeability of the iron which we discussed in the last lecture, the Greek symbol  $\mu$ ; and for the total magnetic flux, the number of magnetic lines, I use the letter  $N$ . Then our law becomes as follows:—

$$\text{Magneto-motive force} = \frac{4 \pi s i}{10};$$

$$\text{Magnetic reluctance} = \frac{l}{A \mu};$$

$$\text{Magnetic flux} \dots N = \frac{\frac{4 \pi s i}{10}}{\frac{l}{A \mu}} = \frac{4 \pi s i A \mu}{10 l}.$$

If we take the number of spirals and multiply by the number of amperes of current, so as to get the whole amount of circulation of electric current expressed in so many ampere-turns, and multiply by  $4\pi$ , and divide by ten, in order to get the proper unit (that is to say, multiply it by 1.257), that gives us the magneto-motive force. For magnetic reluctance, calculate out the reluctance exactly as you would the resistance of an electric conductor to the flow of electricity, or the resistance of a conductor of heat to the flow of heat; it will be proportionate to the length, inversely proportional to the cross section, and inversely proportional to the conductivity, or, in the present case, to the magnetic permeability. Now if the circuit is a simple one, we may simply write down here the length, and divide it by the area of the cross section and the permeability, and so find the value of the reluctance. But if the circuit be not a simple one, if you have not a simple ring of iron of equal section all round, it is necessary to consider the circuit in pieces as you would an electric circuit, ascertaining separately the reluctance of the separate parts, and adding all together. As there may be a number of such terms to be added together, I have prefixed the expression for the magnetic reluctance by the sign  $\Sigma$  of summation. But it does not by any means follow because we can write a thing down as simply as that, that the calculation out of it will be a very simple matter. In the case of magnetic lines, we are quite unable to do as one does with electric currents to insulate the flow. An electric current can be confined (provided we do not put it in at 10,000 volts pressure, or anything much bigger than that) to a copper conductor by an adequate layer of adequately strong—and I use the word "strong" both in a mechanical and electrical sense—of adequately strong insulating material. There are materials whose conductivity for electricity, as compared with copper, may be regarded perhaps as millions of millions of millions of times less; that is to say, they are practically perfect insulators. There are no such things for magnetism. The most highly insulating substance we know of for magnetism is certainly not 10,000 times less permeable to magnetism than the most highly magnetisable substance we know of, namely, iron in its best condition; and when one deals with electro-magnets where curved portions of iron are surrounded with copper, or with air, or other insulating material, one is dealing with substances whose permeability, instead of being infinitely small, compared with that of iron, is quite considerable. We have to deal mainly with iron when it has been well magnetised. Its permeability, compared with air, is from 1,000 to 100 roughly; that is to say, the permeability of air compared with the iron is not less than  $\frac{1}{100}$ th to  $\frac{1}{1000}$ th part. That means that it is quite possible to have a very considerable leakage of mag-

netic lines from iron into air occurring to complicate one's calculations, and prevent an accurate estimate being made of the true magnetic reluctance of any part of the circuit. Suppose, however, that we have got over all these difficulties, and made our calculations of the magnetic reluctance; then dividing the magneto-motive force by the reluctance gives us the whole number of magnetic lines.

There, then, is in its elementary form the law of the magnetic circuit stated exactly as Ohm's law is stated for electric circuits. But as a general rule one requires this magnetic law for certain applications, in which the problem is not to calculate from those two quantities what the total of magnetic lines will be. In most of the cases a rule is wanted for the purpose of calculating back. You want to know how to build a magnet so as to give you the requisite number of magnetic lines. You start by assuming that you need to have so many magnetic lines, and you require to know what magnetic reluctance there will be, and how much magneto-motive force will be needed. Well, that is a matter precisely analogous to those which every electrician comes across. He does not always want to use Ohm's law in the way in which it is commonly stated, to calculate the current from the electromotive force and the resistance; he often wants to calculate what is the electromotive force which will send a given current through a known resistance. And so do we. Our main consideration to-night will be devoted to the question how many ampere turns of current circulation must be provided in order to drive the required quantity of magnetism through any given magnetic reluctance. Therefore, we will state our law a little differently. What we want to calculate out is the number of ampere turns required. When once we have got that, it is easy to say what the copper wire must consist of; what sort of wire, and how much of it. Turning then to our algebraic rule, we must transform it, so as to get all the other things beside the ampere turns, to the other side of the equation. So we write the formula:—

$$s i = \frac{N \cdot \Sigma \frac{l}{A \mu}}{1.257}$$

We shall have then the ampere turns equal to the number of magnetic lines we are going to force round the circuit multiplied by the sum of the magnetic reluctances divided by 1.257. Now, this number, 1.257, is the constant that comes in when the length,  $l$ , is expressed in centimetres, the area in square centimetres, and the permeability in the usual numbers. Many persons, unfortunately—I say so advisedly, because of the waste of brain labour that they have been compelled to go through—prefer to work in inches and pounds and feet. They have, in fact, had to learn tables instead of acquiring them naturally without any learning. If the lengths be specified in inches, and areas in square inches, then the constant is a little different. The constant in that case, for inches and square inch measures, is 0.3132, so that the formula becomes:—

$$s i = N \times \Sigma \frac{l''}{A'' \mu} \times 0.3132.$$

Here it is convenient to leave the law of the magnetic circuit, and come back to it from time to time as we require. What I want to point out before I go to any of the applications is, that with the guidance provided by this law, one after another the various points that come under review can be arranged and explained, and that there does not now remain—if one applies this law with judgment—a single fact about electro-magnets which is either anomalous or paradoxical. Paradoxical some things may seem in form, but they all reduce to what is perfectly rational when one has a guiding principle of this kind to tell you how much magnetisation you will get under given circumstances, or to tell you how much magnetising power you require in order to get a given quantity of magnetisation. I am using the word "magnetisation" there in the popular sense, not in the narrow mathematical sense in which it has sometimes been used (*i.e.*, for the magnetic moment per unit cube of the material). I am using it simply to express the fact that the iron or air, or whatever it may be, has been subjected to the process which results in there being magnetic lines of force induced through it.

Now let us apply this law of magnetic circuit, in the first place, to the traction, that is to say, the lifting power of electro-magnets. The law of traction I assumed in my last lecture, for I made it the basis of a method of measuring the amount of permeability. The law of magnetic traction was stated once for all by Maxwell, in his great treatise, and it is as follows:—

$$P \text{ (dynes)} = \frac{B^2 A}{8 \pi},$$

where  $A$  is the area in square centimetres. This becomes

$$P \text{ (grammes)} = \frac{B^2 A}{8 \pi \times 981}.$$

That is, the pull in grammes per square centimetre is equal to the square of the magnetic induction,  $B$  (being the number of magnetic lines to the square centimetre), divided by  $8 \pi$ , and divided also by 981. To bring grammes into pounds you divide by 453.6; so that the formula then becomes:—

$$P \text{ (lbs.)} = \frac{B^2 A}{11,183,000};$$

or if square inch measures are used:—

$$P \text{ (lbs.)} = \frac{B^2 A''}{72,134,000}.$$

To save future trouble we will now calculate out from the law of traction the following table, in which the traction in grammes per square centimetre or in pounds per square inch, is set down opposite the corresponding value of *B*.

TABLE VI.—MAGNETISATION AND MAGNETIC TRACTION.

<i>B</i> lines per square centimetre.	<i>B</i> lines per square inch.	Dynes per square centimetre.	Grammes per square centimetre.	Kilogrammes per square centimetre.	Pounds per square inch.
1,000	6,450	39,790	40.56	.0456	.577
2,000	12,900	159,200	162.3	.1623	2.308
3,000	19,350	358,100	365.1	.3651	5.190
4,000	25,800	636,600	648.9	.6489	9.228
5,000	32,250	994,700	1,014	1.014	14.39
6,000	38,700	1,432,000	1,460	1.460	20.75
7,000	45,150	1,950,000	1,987	1.987	28.26
8,000	51,600	2,547,000	2,596	2.596	36.95
9,000	58,050	3,223,000	3,286	3.286	46.72
10,000	64,500	3,979,000	4,056	4.056	57.68
11,000	70,950	4,815,000	4,907	4.907	69.77
12,000	77,400	5,730,000	5,841	5.841	83.07
13,000	83,850	6,725,000	6,855	6.855	97.47
14,000	90,300	7,800,000	7,550	7.550	113.1
15,000	96,750	8,953,000	9,124	9.124	129.7
16,000	103,200	10,170,000	10,390	10.39	147.7
17,000	109,650	11,500,000	11,720	11.72	166.6
18,000	116,100	12,890,000	13,140	13.14	186.8
19,000	122,550	14,360,000	14,630	14.63	208.1
20,000	129,000	15,920,000	16,230	16.23	230.8

This simple statement of the law of traction assumes that the distribution of the magnetic lines is uniform all over the area we are considering; and that, unfortunately, is not always the case. When the distribution is not uniform, then the mean value of the squares becomes greater than the square of the mean value, and consequently the pull of the magnet at its end face may, under certain circumstances, become greater than the calculation would lead you to expect—greater than the average of *B* would lead you to suppose. If the distribution is not uniform over the area of contact, then the accurate expression for the tractive force (in dynes) will be

$$P = \frac{I}{8 \pi} \int B^2 dA,$$

the integration being taken over the whole area of contact.

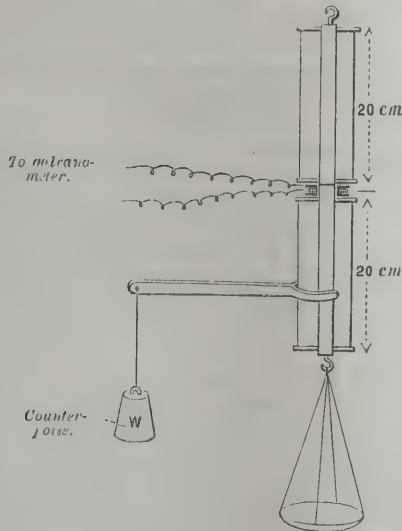


FIG. 22.—BOSQUET'S VERIFICATION OF THE LAW OF TRACTION.

This law of traction has been verified by experiment. The most conclusive investigations were made about 1886 by Mr. R. H. M. Boscquet, of Oxford, whose apparatus is depicted in fig. 22. He took two cores of iron, well faced, and surrounded them both by magnetising coils, fastened the upper one rigidly, and suspended the other one on a lever with a counterpoise weight. To the lower end of this core he hung a scale pan, and measured the traction of one upon the other when a known current was circulating a known number of times round the coil. At the same time he placed an exploring coil round the joint, that exploring coil being connected, in the manner with which we were experimenting last week, with a ballistic galvanometer; so that at the moment when the two surfaces parted company, or at the moment when the magnetisation was released by stopping the magnetising current, the galvanometer indication enabled him to say exactly how many magnetic lines went through

that exploring coil. So that, knowing the area, you could calculate the number per square centimetre, and you could therefore compare *B*<sup>2</sup> with the pull per square centimetre obtained directly on the scale-pan. Boscquet found that even when the surfaces were not absolutely perfectly faced the correspondence was very close indeed, not varying by more than 1 or 2 per cent. except with small magnetising forces, say forces less than 5 C.G.S. units. When one knows how irregular the behaviour of iron is when the magnetising forces are so small as this, one is not astonished to find a lack of proportionality. The correspondence was, however, sufficiently exact to say that the experiments verified the law of traction, that the pull is proportional to the square of the magnetic induction through the area, and integrated over that area.

(To be continued.)

NEW PATENTS—1890.

14077. "Automatic transmitter for submarine cables or long telegraph lines." T. J. WILMOT. Dated September 8.

14090. "Improvements in oil cans especially adapted for use on electrical installations." A. J. JARMAN. Dated September 8.

14155. "Improvements connected with switch boards for telephonic systems." H. T. O. FRASER and J. W. BROWN. Dated September 9.

14168. "Improvements in tools for the making of splices in submarine and other telegraph cables, ropes, and cables." F. FEAST. Dated September 9.

14191. "Improvements relating to electric railways." M. W. DEWEY. Dated September 9. (Complete.)

14193. "Improvements in means or apparatus for controlling, regulating, or automatically interrupting and indicating electric currents." R. LANGHANS. Dated September 9.

14196. "Improvements in incandescent electric lamps." W. R. LAKE. (Communicated by J. B. Tibbits, United States.) Dated September 9.

14197. "Improvements relating to the use of electric motors and to the regulation or control of machinery operated thereby." W. R. LAKE. (Communicated by the Thomson-Houston International Electric Company, United States.) Dated September 9. (Complete.)

14202. "Improvements in apparatus for receiving payments, and for permitting the use of telephonic apparatus in exchange therefor." W. R. LAKE. (Communicated by P. Bonamico, Italy.) Dated September 9.

14204. "An improved electric miners' safety lamp." G. C. LEVEY. Dated September 9.

14260. "Improvements in electric or magnetic carrier systems, otherwise known as port-electrics." H. J. HADDAN. (Communicated by J. T. Williams, United States.) Dated September 10. (Complete.)

14341. "Improvements in electrical apparatus for reproducing sound." J. E. ROULEZ. Dated September 11.

14349. "An improvement in electric meters." SIEMENS BROS. AND CO., LIMITED. (Communicated by Siemens and Halske, Germany.) Dated September 11.

14368. "An automatic electric lighting contrivance for staircases." L. A. THRANTZ. Dated September 11.

14394. "Improvements in electric bells." F. W. WHITE and E. F. FURTADO. Dated September 12.

14459. "Improvements in electric bells or sounding apparatus." E. EDWARDS. (Communicated by G. Bénard, France.) Dated September 13.

14460. "Improvements in electric bells." E. EDWARDS. (Communicated by G. Bénard, France.) Dated September 13.

14482. "An improved connection for electroliers or electric chandeliers." R. B. EVERED and T. RUDLING. Dated September 13.

14484. "An improved combined electric switch and connecting or coupling device." R. B. EVERED and T. RUDLING. Dated September 13.

14536. "Improvements relating to means for connecting glow lamps to their holders and for connecting together the parts of other electrical apparatus." H. J. F. VOIGT and J. STAUDT. Dated September 15.

14548. "Improvements in the art of and apparatus for telegraphing and telephoning and similar purposes." S. L. WIEGAND. Dated September 16. (Complete.)

14553. "Improvements in and relating to train signalling apparatus." R. S. HAMPSON and R. FORSTER. Dated September 16.

14603. "Improvements in electric signalling apparatus." W. R. LAKE. (Communicated by the Hall Signal Company United States.) Dated September 16. (Complete.)

14604. "Improvements relating to the heating of metals and other materials by electricity." M. W. DEWEY. Dated September 16. (Complete.)

14609. "Improvements in electrically propelled vehicles in the arrangement and connections of the motors and power transmitting devices thereof, and the method of operating the same, a

portion of the invention being applicable to the transmission of power for other uses." B. J. B. MILLS. (Communicated by E. H. Johnson, United States.) Dated September 16.

14613. "Electric-motor car." W. ROBINSON. Dated September 16. (Complete.)

14624. "Improvements in the manufacture of metallic articles by electrolysis and apparatus for that purpose." A. S. ELMORE. Dated September 16.

14627. "Improvements in shadowless arc electric lamps." A. G. MELHUISE. Dated September 16.

14634. "Improved apparatus for electric light signalling." E. F. INGLEFIELD. Dated September 16. (Complete.)

14666. "Improvements in electric switches." J. CHARTERS. Dated September 17.

14679. "Improvements in electrical alarm apparatus for shops, stores, and other purposes." W. WILKINSON and W. A. SYKES. Dated September 17.

14686. "Improvements relating to the preparation or treatment of carbons for electric lamps or lighting apparatus." W. R. LAKE. (Communicated by Lacombe & Co., France.) Dated September 17.

14696. "Improved telegraphic relay." J. P. BAYLY. (Communicated by J. M. Treber, United States.) Dated September 17.

14698. "Improvements in conductors for the distribution of electrical energy, and in apparatus connected therewith." R. E. B. CROMPTON and W. A. CHAMEN. Dated September 17.

14748. "Improvements in apparatus for electrically giving alarm from letter plates, post boxes, and other purposes." P. WILLIAMS. Dated September 18.

14776. "An improved process and means for the electro-deposition of metals." C. T. J. VAUTIN. Dated September 18.

14807. "An improvement in the supply of electricity in medical cases." J. GNEZDA. Dated September 19.

14817. "Improvements in and relating to the distribution of electrical energy." R. KENNEDY. Dated September 19. (Complete.)

14830. "Improved means of accommodating electric wires in buildings." F. WALTON. Dated September 19.

## ABSTRACTS

### OF PUBLISHED SPECIFICATIONS, 1889.

6544. "Improvements relating to electric incandescence lamps." A. A. GOLDSTON. Dated April 16. 8d. The object of the invention is to provide such lamps with improved cut-outs, adapted to operate automatically when the carbons or light-giving conductors become destroyed. 5 claims.

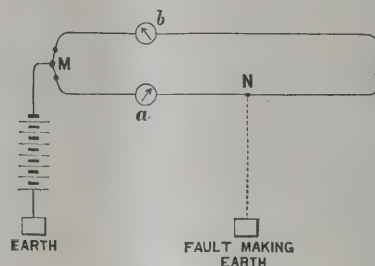
6578. "Improvements in arc lamps." G. HOOKHAM. Dated April 17. 8d. The feed mechanism is actuated by the weight of the upper carbon and the carbon holder. The descent of this weight is retarded by the eddy currents generated in a Foucault disc. 1 claim.

6675. "Improvements in electrically-driven fans." H. G. WATTEL. Dated April 18. 6d. The inventor converts the rim of the fan into the armature of an electro-dynamic machine, or he applies the ring armature of such a machine to the periphery of the fan, and converts the fixed framing within or against which the fan works into field electro-magnets, or he applies such field magnets to the framing. 2 claims.

## A SPEEDY METHOD OF LOCALISING DEFECTS IN AN ELECTRIC LIGHTING CIRCUIT.

THIS is described by M. Henri Wilbrant (*La Lumière Electrique*), who recommends it for its simplicity. An earth connection had formed in the negative conductor of a double line, the latter being composed of two parallel and identical protected cables laid in the clay. The following diagram indicates the way in which the defect was localised:—An ampèremeter is attached to each conductor where the line commences, and both conductors are united together to a powerful battery of accumulators. At the end of the line the conductors are looped together. The battery being connected to the earth at its other extremity the current is closed by the defect and by the conductors forming the shunts,  $M b N$ , and  $M a N$ . Measures have been taken for obtaining an intensity of current that will render the reading of the ampèremeter an easy matter. The readings,  $a$  and  $b$ , are inversely proportional to the resistances of the circuits in which the instruments have been inserted, and, as the conductor cables are

identical, the resistances are directly proportional to the lengths in metres. It is as well to take into account any resistances from accessory loose cables in effecting the junctions with the ampèremeter and the battery.



Let  $x$  represent the length in metres from the commencement of the cable to the defect (shunt  $M a N$ );  $L$  the length in metres of the two cables (this length having been previously ascertained), and  $a$  and  $b$  the number of the ampères indicated by the instruments, the ordinary calculation of the ramified circuits is:—

$$x = \frac{b L}{a + b}$$

In applying this method to the total length of a 900 metres line, an approximation was obtained of close upon 5 metres, the difference being attributable to difficulty in reading from ampèremeters of the ordinary type.

## COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

THE Buda-Pest electric town tramline makes constantly so satisfactory advances, that it already appears necessary to enlarge the central current installation of this line. On behalf of the undertaking of the town line which is applying for the concession of the execution of this extension, its necessity is urged along with the establishment of a new line, on account of the increased traffic on the most important lines. The concession will, without doubt, be granted.

At the Innsbruck electric central station, an interesting case has occurred. A spider was climbing, during the work, on one of the lightning protectors, and occasioned an earth connection, in consequence of which an induction bobbin was damaged by breaking the insulation. In order to prevent similar occurrences for the future, the lightning protector plates are closed up in glass boxes. The spider itself has paid with its life for its unwarranted intrusion into the primary circuit of 2,000 volts.

The Vienna Electric Company (not to be confounded with the International Electric Company, also established in Vienna), has erected in the Neubad Gasse an electric central station, with the use of the five-lead system. For employing this system in one of the most densely-populated quarters of the city, the company had to erect electrical works which naturally occasioned serious annoyance to the inhabitants, and, in consequence, an endless succession of law suits. The peculiar situation in which the company is now placed is illustrated by the following notice from the Vienna *Extra-blatt*. Says this paper: At last the thoroughfare through the Neubadgasse into the Naglergasse, after being closed for three years, is reopened. Still the process between the inhabitants and the electric company is not yet decided. The inhabitants, especially Prince Esterhazy (represented by Dr. Lichtenstern), Herr Wieser, of the Neubad Hotel, and Herr Haag, of the Hotel Müller (represented by Dr. Peiez), and the Knight von Weissenfeld (represented by Dr. Ziegler) have entered actions against the company, as the powerful machinery disturbs the quietness and causes the walls to vibrate. The company has been

ordered to construct the machinery so as to abate the nuisance. But it has latterly appealed against this decision, and there is now a perfect complication of appeals, protests, decrees, and decisions. One night a 400 horse-power engine at the central station was set in action, when confusion at once arose in the adjoining houses, the walls trembled, the windows rattled, and Prince Esterhazy leaped out of bed in dismay. Count Kielmansegg the "Statthalter," a municipal official of higher rank than a mayor, at once visited the Prince's palace and the hotels Müller and Neubad, and convinced himself of the reality and the nature of the disturbance.

### THE SEVILLE CENTRAL STATION.

A CENTRAL electric light station has been erected in the Calla de Las Mozas, Seville, and is described in a newspaper published in that town. The boilers comprise six of the well-known Belleville type, and four vertical compound Offman steam engines. Four compound dynamos of the Brown type are installed, each having an output of 480 ampères, at a difference of potential of 110 volts. These dynamos and the engines were made by the well-known Oerlikon Engineering Works, near Zürich, whilst the regulating apparatus was furnished by Messrs. Woodhouse and Rawson United.

The distribution of current is effected by means of mains laid underground. These mains consist of copper wires insulated by vulcanised rubber, and then encircled with leaden tubes, and laid in iron pipes, which form the conduit. Current is obtainable both day and night. The incandescent lamps employed range from 10 to 1,000 candle-power, and the arc lamps from 500 to 1,000 C.P. The price charged for current compares very favourably with that of gas, even when the cost of wiring is considered. Already a number of subscribers has been obtained, and, notwithstanding the local opposition, it is expected that the station will become a commercial success, and probably be the forerunner of several others in Andalusia.

### CONFERENCE OF POSTAL TELEGRAPH CLERKS.

A SPECIAL conference of postal telegraph clerks will be held in Liverpool to-morrow, when the features of the recent revision of their status will form the chief subject of discussion. The importance of such a meeting can scarcely be exaggerated when it is remembered that the delegates attending represent the whole of the members of the postal telegraph staff throughout the United Kingdom, this section of the public service alone numbering, we believe, upwards of 10,000 members.

That the deliberations of this assembly will be followed with peculiar interest and concern by all parties throughout what is termed "the service" goes without saying, and to many who are not telegraph clerks, but who trace the course of current events, the reintroduction of that outcome of the "benevolent disposition" of the Postmaster-General and his administrators, "the official reporter" will revive the recently-discussed topic of the right to "free public meeting."

Many of our readers will remember the restrictions placed this year on all sections of Post-office *employés* holding such meetings, their general and almost unqualified condemnation by the press, and their plausible interpretation by the Postmaster-General in the House of Commons and elsewhere. General doubt was expressed as to the genuineness of the "benevolence" attending such unnecessary limitations, and it is melancholy news indeed to hear that the movement which the telegraph clerks have carried on so moderately and constitutionally has not been signalled by equal forbearance and consideration on the part of those

for whom the Postmaster-General has professed almost too much in the House of Commons. We refer now to the dismissal of a well-known and popular member of the London staff; a young man whose only faults appear to have been his manly candour and his unswerving honesty of purpose.

Elected by the staff of the Central Telegraph Department to a position on the executive committee, intelligent, enthusiastic, and, as we have already said, honest, he in some way fell foul of the higher authorities, his dismissal being due to "what he had said," though where and when the negative or positive oration which led to this result was delivered was not vouchsafed.

It is gratifying, however, to learn that a promising opening has already been found for this young man, and that he has little to regret in leaving the Telegraph Department beyond the loss of seven or eight years of underpaid service. Possibly, if he be of a thoughtful or enquiring turn of mind, he may ask, in the words of Burns—

Why was an independent wish  
E'er planted in my mind?

and, for an answer, the Postmaster-General might commend him to the same poet's lines on "The Creed of Poverty." Under the circumstances he will amply realise their point.

As might be expected, the delegates attending the conference will be asked to give utterance to an expression of sympathy with their late colleague.

It is no doubt one of the stock arguments of the Civil Service at such times, that examples must be made, and, that the line, as the hangman said, must be drawn somewhere, so we are not surprised to hear that others are under a certain degree of official displeasure. The effect of such incidents on the calm debating spirit and general character of a conference such as that under notice cannot be said to be reassuring, but we trust that in all its transactions the special conference of telegraph clerks will refrain from taking up a position which might be construed as expressive of resentment, defiance or disgust, at the same time exhibiting neither timidity nor panic, but holding steadfastly on for the recognition of those claims which are reasonable and justifiable in the general interests of all classes of postal telegraph clerks.

We have made a careful study of the new scales of pay, their methods of application, new system of sick pay, hours of duty, the matter of annual leave, and last, but not least, the vexed question of a "reasonable prospect." These important points it is our intention to discuss more fully hereafter. We find that much as has been done by the Postmaster-General and those who have been at his right hand throughout the framing of the new scheme, there still remains much to level up and much to clear away.

The substantial benefits conferred must not be lost sight of by the conference, neither should they be overrated, as some of the reforms may be said to be more apparent than real, and it will not be until July, 1891, that the general body of telegraph clerks will feel any appreciable improvement in their salaries.

It will not inspire the public with very high ideas of the way things are being administered in the telegraph service when it is known that increments were given under the new scheme at some of the provincial offices recently, and recalled in a week or two after. This may be a playful method of perpetrating a joke, but there is something very clumsy about it notwithstanding, and no one will envy the feelings of the unfortunate individuals concerned.

Whether the revision of the new scales of pay may be practicable at the present time or not we cannot say, but it is stated that they are not regarded as being entirely satisfactory, and we believe that moderate and rational methods will gain for the telegraph clerks the more equitable settlement of such minor points as appear to us to require improving. For instance, the inconsiderate system of stopping the pay of the poorer sections during absence through sickness, whilst others have gained the great boon of exemption from deduction or stoppage, will,

we think, if properly represented, be remedied. The question of annual leave will also bear remodelling, and we are hopeful that the Postmaster-General has not yet exhausted his beneficial resources; and no doubt the conference will recognise other features on which they may feel it their duty as well as their privilege to approach the Postmaster-General.

## CORRESPONDENCE.

### Alternating Current Meters.

Referring to the letter of Mr. Tesla in last week's ELECTRICAL REVIEW on the subject of alternating motors, I should feel obliged if you would allow me to modify some statements therein contained with reference to an alternating current meter devised by Messrs. Alderton, Philpott, and myself, and recently perfected by Mr. Ferranti.

In August, 1888, while experimenting with an alternating current meter made on the principle suggested by Prof. Ferraris in the spring of that year, viz., surrounding a copper cylinder, capable of rotating, by two coils at right angles to each other, through which two currents differing in phase were passed, the difference of phase being obtained by using the currents from the primary and secondary of an induction coil. I modified this arrangement by substituting Mr. Tesla's ring-shaped field with two pairs of coils wound on the quadrants, and passed through these two circuits respectively, currents from the primary and secondary of a transformer, instead of using a special two-phase generator, as employed by Mr. Tesla. Then a co-worker of mine in the same field, Mr. G. Alderton, suggested making the above ring-field act as the transformer itself by short-circuiting on themselves a few turns of copper wire in two opposite quadrants and sending an alternating current through the other quadrant's coils. This answered, but was greatly improved by making each of the two short-circuited secondaries only cover an octant instead of a quadrant, and the first meter of this form was put in the Grand Hotel at Brighton in September, 1888.

Mr. G. J. Philpott then discovered that rotation of the iron disc could be produced by placing it in the field formed of laminated iron stampings of the shape of a J, the disc being put near the curved part of the iron, and the straight part magnetised by an alternating field. We then found that the rotation was very much accelerated by putting a few short circuited turns of copper wire round part of the iron magnet which was uncovered by the exciting coil. Within a week of this improvement being made, we were naturally disappointed to find in the ELECTRICAL REVIEW that Prof. Elihu Thompson had forestalled us in some of our forms, and in enunciating the most probable cause of these rotations, namely, the gradual movement of the magnetic poles along a mass of iron in or around which secondary currents are allowed to be generated, or as Dr. Fleming happily puts it, "a gradual shifting of a magnetic pole takes place owing to the *high magnetic self-induction of the core*." I may add that Mr. Philpott found that these rotations could be observed in certain positions near a loaded transformer in which the magnetic leakage was excessive, and thus formed a rough test of the transformer's defect in this respect.

I quite think with Mr. Tesla that his latest method of obtaining rotations by magnetically screening part of the iron poles is distinct from the method mentioned above, but think he is wrong in stating that the rotation in our meter is due to the same cause as that in the Schallenberg form. There appears to be several methods of producing this valuable effect of rotation of an armature without collectors or commutators, in an alternating field, which do not necessarily all require the same explanation. For instance, I would refer your readers

to the interesting electrical apparatus devised by M. Fontevielle and described in the ELECTRICAL REVIEW in July 1880; also to the wonderfully ingenious meters devised by M. Borel and Paccaud in 1887 and patented in this country in January, 1888. Perhaps the above may show Mr. Tesla that it is quite possible for different individuals to work in this interesting field, without the fact of like results being obtained, in any way detracting from the individual merits of their labours, or that there can be only one cause for these rotations.

Arthur Wright.

October 7th, 1890.

### Telephone Induction Coils.

In your last number you have a description under this heading of an arrangement by Mr. T. D. Lockwood in which a closed magnetic circuit induction coil is used in conjunction with an ordinary open ended coil. It is not, however, of this that I wish so particularly to speak as of the editorial note appended, in which you state that you "witnessed some experiments a few years ago with coils constructed like transformers, to be used for translation purposes from a single wire to a double wire system, but the speaking results were extremely poor, though the ringing of the call bells (in the magnets principally), was all that could be desired. On the other hand it was found that when ordinary induction coils were used as translators the speaking was excellent, but the magneto bells would not ring."

Now in connection with a patent taken out in 1885 by Mr. Ferranti and myself we carried on an extended series of experiments with coils of this character, particularly with a view to their use as you describe, viz., as translators from a single to a double wire or *vice versa*, and with the intention that the call signals should be made right through both coils by induction without the intervention of any extraneous apparatus. Several curious and interesting effects were obtained exactly in accordance with theory, in fact such coils can be made to illustrate many of the laws of induction in a most pleasing and convincing manner.

The results vary in accordance with the way the coils are constructed, but it is by no means the case that when the coils are properly made the speaking results are extremely poor. In some experiments at the telegraph office on an underground wire to Gloucester Road, for which facilities were kindly afforded by Mr. Preece, the speaking through the coils best suited to the work was found to be indistinguishable from that through coils which the Post Office authorities, after many experiments, had found to give the best effects. In addition to this of course the closed circuit coils possessed the advantage that call signals could be transmitted through them, even when the resistance of the circuits was considerable.

It is true that coils can be constructed to give astonishing results when signalled through, but in which the speaking is poor, if the main line has any appreciable capacity, such a form, however, must be avoided.

I send you this note in the interest of closed circuit coils when used as translators. When used as transmitter coils they certainly do not appear to be successful, no doubt for the reason advanced by Mr. Lockwood.

The whole subject, however, demands fuller and more exact treatment than it has yet received.

G. L. Addenbrooke.

October 1st, 1890.

### Electrical Heterodoxy.

It can be easily seen there was no attempt to disguise the logomachy of my letter, the whole subject has been a contention of words ever since Benjamin Franklin enunciated the one force theory of elec-

tricity, in which positive and negative (now + and -) mean plus and minus.

But why does Mr. Johnstone take me to task over the one particular paragraph, there is not a great deal of logomachy in contending that plus and minus electrification and the quality of polarity do not necessarily force one to believe in two electricities. If plus and minus anything are not opposite and therefore polar qualities, I fail to understand what + and - mean. Had I written positive and negative electricity Mr. Johnstone's objection might be valid. I am not so sure the other paragraph would have remained unwritten had I perused Mr. Johnstone's book, it would take a lot of evidence to prove to my satisfaction that glass is porous in the sense referred to. Mr. Johnstone writes of electric matter passing through the pores of glass. What is this "electric matter"? A substance of course, or it could not be matter and what are these "particles of a current of electricity." In contending for his "electric matter" Mr. Johnstone must beware of getting logomachic, for there was a theory of an electric fluid, and I suppose fluid must be matter. I presume the test tube used by Mr. Johnstone, also the several referred to in the editorial article were (according to Mr. Johnstone) sufficiently porous to let the "electric matter" through. Notwithstanding Mr. Johnstone's theory that a Leyden jar becomes charged because of the smallness of the glass pores and therefore the above series of test tubes most unsuitable material, I fancy few experimentalists will hesitate to say the whole lot of these non-perforated porous tubes would make very fair Leyden jars.

Really there is little necessity for me to read Mr. Johnstone's book.

It would have been more to the point had Mr. Johnstone shown the apparatus illustrated in my letter *did not* tend to prove the explanation in the editorial article and also to have shown that my surmise, *re* the gas flame was incorrect.

But why this contention for electric matter, fluid or what not? When things might be simplified by the endeavour to demonstrate that electrical effects are the results of certain conditions of motion in the matter of the circuit itself, whether the effects or circuits be electric or magnetic, I have not brain power sufficient to say how and why but feel sure a future Faraday will arise and put us right in simple and truthful language.

As this logomachic correspondence can do little else than waste valuable space, it is concluded so far as I am concerned.

Henry Sutton

October 4th, 1890.

#### Fusible Cut-Outs in Armatures.

Your correspondent "E. J. M." will find his enquiry of 5th ultimo answered by referring to United States patent, No. 281,904 of July 24th, 1883, wherein I have covered the use of fusible plugs between each section of the armature and the corresponding segments of the commutator of both dynamos and motors.

J. M. McMahan.

October 2nd, 1890.

#### Reciprocating and Stationary Lines of Force.

Prof. Elihu Thomson, in his recent communication to you in your issue of September 26th, appears doubtful as to whether the lines of magnetism emanating from the axial solenoid in his new machine rotate with the revolving core and armature; and we are told "the actions would be the same whether they rotate or not." This, I think, is a somewhat hasty conclusion, even from such an authority; for if the classification of physical or magnetic actions is permissible, and, as experience teaches, desirable, then the distinction between fixed magnetism and reciprocating or vibrating mag-

netism would determine the category in which this machine should be placed: if in the induction coil class or with the Gramme or Siemens type of continuous current machines.

The former depend for their current on reciprocating lines of force intersecting an electrical conductor, while the latter produce current by the continuous movement of a conductor through fixed lines of force.

It is as well to be clear, to lay hold of the right line of thought, to see the path we are treading and whither it may lead, even though ultimate results may at present be obscured by the mists of uncertainty. It is reassuring to feel that one is on the right track.

Like a man, a dynamo has an inside and an outside. The latter may not be impressive or picturesque; but it is the inner life, the lively and conflicting forces to be seen only by the mind's eye, that makes electrical contrivances so interesting.

Logically, it would appear desirable to call all machines induction coils or transformers that depend on the reversal, variation, or cessation of magnetic force; whether these changes be brought about by an automatic contact breaker or by the mechanical rotation of masses of iron under inductive influence; the necessary periodicity of change in magnetic state being produced either electrically, by the make and break apparatus; or mechanically, by the rotation of an iron armature of a suitable shape, so as to cause a rhythmic and variable magnetic action.

It is feasible that the *result* would be the same—that is, more or less—whether the magnetism revolved or not in Prof. Thomson's alternator. But a result may be the consequence of many actions, and it is a legitimate field for enquiry to find out what these actions are.

There would seem to be much opposed or conflicting magnetism in this alternator—possibly a detail question in construction. For instance, the bobbins on the periphery of the machine are double in number to the projections of the armature; and by the continuity of the magnetic circuit, which obtains its energy from the axial solenoid, all the bobbins are in themselves more or less saturated, and all of like polarity, without reference to the armature. But as the armature can only cover half the number of bobbins, it follows that a polarity of opposite sign must necessarily be induced in every alternate bobbin not covered by the armature, and this sign would be opposed to that which it would acquire from the framework of the machine, while its direction would be at right angles to it. There are some conflicting forces here.

With reference to the distribution of the lines of magnetism in the core or axis, and in the armature itself, if the armature were a drum instead of being variable in mass, I am certain it would rotate through the magnetism the same as the core of a Gramme armature passes through the magnetism held in space by the inductive action of its field magnets. The fact of the armature being irregular in shape, or heterogeneous in mass—having regard to the space it occupies in revolving—is why I have a little doubt about its action.

It is the excitation of the solenoid that brings the magnetism into existence, and that is a fixed element. If the cause is stationary, should not the effect be stationary also? I cannot conceive magnetism to be elastic; if it were so, dynamo machines would have been an unknown commodity and an impossibility. I have written on this part of the question before in the columns of your contemporary, the *Electrician*, 1887.

Enclosed is an illustration or suggestion for an experiment which would decide the point. I have no opportunity for making it myself. On the shaft (fig. 1), each side of the armature, is a metallic band, insulated from but fixed to the shaft. A number of copper strips are in electrical communication with the bands, and go over and enclose the armature as shown, preferably placed at about the centre of each cavity of the armature. Collectors on each side. The central and exciting coil and the frame are shown in section, while the armature with the conducting strips is in perspective.

Now, if the magnetism rotates with the armature,

there should be no decisive indication of current through the collectors, because if the magnetism rotated at all, it would travel at the same speed as the armature and the conducting strips. But if the magnetic lines are stationary, then there should be unmistakable evidence of current; in fact, it would be a continuous current dynamo of its kind.

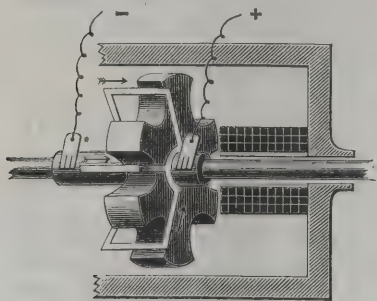


FIG. 1.

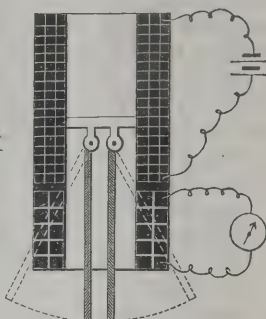


FIG. 2.

However, the immediate or direct cause of current in Prof. Thomson's machine may be explained on the reciprocating or vibrating principle. Let fig. 2 represent the section of a compound solenoid having a primary and secondary coil, the secondary being wound on the end. It is not difficult to make an iron model of a line of force, greatly magnified, no doubt; and for convenience of illustration some are hinged and suspended at the inner side near the equatorial part of the solenoid. Let the primary coil be excited, and these iron lines of force will repel each other, and strive to cut their way through the coil in order to assume the position shown by the dotted lines. In doing so they will have intersected the wire of the secondary coil, and have generated the inverse current. Break the primary circuit, and the magnetic lines cut the coil again, by falling back into their first position, generating the direct current.

When the magnetic lines remain in their extended position, by reason of the primary current, the rapid rotation of an irregular mass of iron near the end of the magnet would cause the lines of force to vibrate through the secondary coil and generate alternate currents similarly to an induction coil.

E. L. Voice.

39, Gower Place, W.C.,  
October 6th, 1890.

#### The Elmore Copper Companies.

Assuming the Elmore process to be a success there is as much justification for a company to work it in every country which uses the metal as there is for an English company, and the probability is that one would be formed for Timbuctoo if occasion warranted. But the laws of political economy cannot, unlike, therefore, the copper industry, be revolutionised, and supply will always be subservient to demand, and Timbuctoo will be without its Elmore company.

It having been proved that the process is a success and valuable, no criticism will be logical which condemns the Austrian and French Companies without condemning at the same time every other Elmore company. To prove the value of the process two things have to be shown; firstly, that the tubes which are admitted to be produced, have intrinsic merit and consequently marketable value, and, secondly, that the cost of manufacture is commensurate with the price the product will obtain on the market. This is the nut-shell of the whole case, and whatever the results may be the connection of Messrs. Woodhouse and Rawson with the process neither makes it better nor worse.

An enquiry on the above two points would have elicited such information as I will give you, and with these facts before you, instead of condemning without

enquiry an invention you should encourage, your six columns might have been devoted to better purpose. Now, as regards the first point; every expert who has tested the tubes has satisfied himself that they are much stronger than those made in the ordinary way, and, as a matter of fact, the company guarantees that every tube it supplies shall have a tensile strength far above that of any tube of similar dimensions.

As to the second point, namely, the cost of production, the company is now, and has been for some time, working at an actual cost of  $\frac{1}{2}$  d. per lb. of deposit, and this statement has been confirmed by Dr. Hopkinson, who visited the works last week. This is, by the by, very much less than Mr. Elmore's original estimate, which, I think, came to over 1d. per lb. Now, I have shown on evidence which cannot be fairly disputed, that the company produces a superior article at a ridiculously low price; and the sole remaining point remains, Is there a market for the company's commodities? Given a better article at a lower price, common sense will tell one what the result will be.

The statement of Mr. Clark to which you refer in your article, has no bearing on the case, for the simple reason that he was alluding to ordinary electro-deposited copper, which for utility cannot be compared with Elmore copper; while as to the extract from Mr. Parker's report, with its obvious error in the proportion of the decrease of tenacity, no stronger evidence can be given of this gentleman's opinion than the fact that he has become a shareholder in the company since the date of his report.

Good wine, notwithstanding the old maxim to the contrary, does need "bush," and before anything can be appreciated at its true value, time, labour, and advertisement must ensue. I thoroughly believe in the impending revolution in the copper industry, but I am, although a shareholder in the Elmore companies and therefore, according to you, a fool, not sufficiently foolish to think that it will be effected in a few months.

A Shareholder.

#### The Sweating System.

Kindly allow me through the medium of your widely read journal, to call attention to the rapid strides that are being made in the electric lighting industry by that common enemy the sweater. Although our business is comparatively new, the sweater is there in all his glory, competing seriously with first class firms who pay fair wages which will cause them eventually to reduce theirs. It behoves both employers and employees, whose interests are inseparable, to make a determined stand against these men, and they cannot start too soon. Other trades, just lately, have had to fight this question out and undoubtedly we shall have to do so in the near future. It is not alone the small wages paid by these men, but it is the bad material that is put in, thus injuring our trade by the constant breakdowns that occur, and preventing intending users from adopting the light. The only remedy that I can see is by the first class firms combining and crushing the men off the market.

Being a member of the Electrical Trades Union, and knowing a great many, both union and non-union men, there is amongst them a genuine desire on their part to do something to eradicate this pernicious system, or we shall be obliged to work for little better than a starvation wage; and I am heartily ashamed to know that many of these sweaters originate from men of our own class. I should like to ask my fellow workmen what they are going to do? If they stand aloof they are against themselves and the men who desire to put a speedy end to this pernicious system. Hoping that the outcome of this letter will be to bring forward some practical suggestions from employers and employees,

An Electrical Trades Unionist.

October 7th, 1890.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## THE ELECTRO-DEPOSITION OF COPPER.

ACCORDING to determinations by Lord Rayleigh and Prof. Roscoe, a current of 1 ampère will in one second throw down from a solution of sulphate of copper .0050478 grains of the pure metal. To deposit, say, 20 tons in one week of 60 working hours, would require a current of

$$\frac{20 \times 7000 \times 2240}{.0050478 \times 60 \times 60 \times 60} = 287,620 \text{ ampères.}$$

Now, according to Sprague, the maximum allowable current for obtaining proper deposition is 18 ampères per square foot of surface of the electrodes; this, with the current above calculated, is equal to

$$\frac{287,620}{18} = 15,979 \text{ sq. ft.} = 127 \text{ ft.} \times 127 \text{ ft.}$$

Probably by the use of the burnisher, as in the Elmore process, a more granular form of deposit could be allowed, and a somewhat heavier current be employed per square foot of surface; but, in any case, the latter must be very large indeed. In order that the current named may be possible, the resistance of the circuit under an electromotive force of 1 volt must not exceed—

$$\frac{1}{287,620} = .0000034768 \text{ ohm,}$$

and this could not be obtained in a single depositing cell with the plates at a greater distance apart than a few inches only. Placing a number of depositing tanks in series would not make matters any better, for what is gained in one respect is lost in another. It would appear then that to deposit 20 tons per week would involve the use of enormous tanks, worked under conditions which would be practically impossible except at a heavy outlay for plant and tank space.

As regards the cost of deposition, to throw down 1 ton of copper under an electromotive force of 1 volt would require

$$\frac{2240 \times 7000}{.0050478 \times 746 \times 60 \times 60} = 1156.7 \text{ H.P. hours,}$$

taking the case of one depositing tank only being used.

Now the average cost in cities of 1 H.P. for one year, taking a working day of ten hours and six working days per week, is known to be about £10, which is equivalent to .76923d. per hour; to deposit, therefore, 1 ton of copper under a total electromotive force of 1 volt in one depositing tank would cost

$$\frac{1156.7 \times .76923}{12 \times 20} = £3.7072.$$

If the working electromotive force were less than 1 volt, then the cost would be proportionally less, but this, on the other hand, would involve a great increase in the size of the depositing tanks to enable the required current to pass. Of course the cost per ton would in actual practice be considerably more than the bare theoretical, as calculated above, as wages, factory expenses, depreciation on plant, interest on capital involved, and the many contingencies which will readily occur to everybody, have to be added, and these must be heavy, considering the extremely slow rate at which deposition takes place.

Now to show what occurs in actual working. In a well-known volume on electro-deposition we find the following:—"At the North German Works there are 40 baths arranged in two series of 20; the anode surface in each bath is nearly 325 square feet, giving a total of 13,000 square feet of surface for the whole of the baths. The copper is deposited on the cathodes to the thickness of about  $\frac{1}{5}$ th inch, and at the rate of about 64 lbs. per hour in all the baths, or 1,760 lbs. per day of 24 hours. The production is 1 lb. of pure copper with a consumption of 0.4 H.P. per hour." It will be seen therefore from this example of operating on a scale of nearly a ton per day that the production necessitates 900 H.P. hours per ton.

At the Elliott Metal Refining Company's Works, near Birmingham, there are employed vats arranged in five series of forty-eight in each. Each vat contains 16 anodes, weighing 26 lbs. each, which are replaced every five weeks, and the operation progresses for 156 con-

secutive hours per week, the yield of copper for the forty-eight baths being approximately 30 lbs. per hour, or about '65 lbs. per bath per hour.

Taking, then, into consideration the cost of solution, the replacement of anodes, and using a boiler and steam engine as the source of motive power, it is difficult to reconcile the report made by Dr. Hopkinson, who, whatever he may do in theory, will not get his horse-power hour for less than three farthings in practice, with what must be the actual state of affairs, and it is only right and just that the Elmore directors should lay before their shareholders and the public a detailed statement of the actual cost incurred in producing their wares.

It is possible that Mr. Stepney Rawson could help us to this desirable end, or if the authorities which we have mentioned have been erroneously quoted perhaps he will show where the flaw exists, as we hope to return to this subject more fully in another issue.

### THE JOHNSON STORAGE BATTERY.

A FORTNIGHT ago we received a letter from Messrs. Ramsden & Co., announcing the shipment from Boston, U.S.A., of a set of secondary batteries, manufactured by the Johnson Electric Supply Company. This letter stated, among other things, that "the battery is entirely novel in its construction, as also the method of combination of the active material and the lead plates, the active element being suspended in a net-work or box of lead—very rigid and firm in construction—while ample allowance is made for the necessary amount of expansion and contraction without the slightest warping or buckling in the plates." Reference was made to various tests undertaken by sundry experts, among which is one experiment "with 30 Johnson cells weighing about 21 lbs. each, running 14 16-candle power lamps from a single charging for 21 hours and 30 minutes, the rate of discharge dropping during this time from between 10 and 11 ampères to about  $9\frac{3}{4}$ ." The importers of this battery add the following statements:—"We think we have the storage battery of the future, as its capacity, efficiency, and durability, as well as cheapness of construction, are absolutely unprecedented. It is quite indestructible in any legitimate use required of a battery, actual short-circuiting and welding of iron wires upon a single cell having no deleterious effect upon the plates. Ten cells were charged in Boston before shipment, and will be drawn off at the electrical works in Westminster some day next week."

We were naturally anxious to see this remarkable invention, and test the accuracy of the above assertions, so when the invitation to view the cells arrived, we proceeded to the place of exhibition. Mr. Johnson, the inventor, kindly answered numerous questions put by several gentlemen present, showing the method of constructing the plates, and giving the following data upon the cells on exhibition. The set of eleven cells before us had been discharged at the works at Boston, and gave a capacity of 260 ampère

hours, working at the rate of 13·5 ampères; the E.M.F. at the commencement was 22 volts, and at the end of the discharge 18·91 volts. The weight of the electrodes in each cell was stated to be 33 lbs.; the total weight of each complete element, however, could not be ascertained. This performance shows no advance whatever upon well-known English types of storage batteries, and the arguments naturally turned upon questions of durability and cost. As to durability, the oldest cells have only been in use for two years, and we were not favoured with a view of samples of that age. As regards cost, we could not see how and why the plates on exhibition should be cheaper than those already in the market.

Mr. Johnson's plates are made of lead and oxides of lead, requiring as much material as any other lead battery. The plates consist of ribbed sheets of lead, perforated in such a manner that a "burr" is left on the inner side of each hole. Two such sheets are placed back to back, and the space between them is packed with a paste of red lead. We have been unable to discover any striking novelty in this construction, and we cannot see why such a lead plate should be "indestructible," no means being taken to prevent the sheet metal becoming oxidised with the rest. Mr. Johnson modestly acknowledged that to bring storage batteries to England was like taking coals to Newcastle, the industry here being more highly developed than in America, and he only yielded to the pressing invitation on the part of his London representatives, who issued the letter above referred to, and who are evidently under the impression that this is "the battery of the future." No doubt the "future" will decide whether this is so.

The Vaughan-Sherrin  
Battery.

WE are pleased to note that M. E. Hospitalier has not left us to do battle alone with Prof. Silvanus Thompson. From the last issue of *L'Electricien* we extract the following, which deals mainly with Dr. Thompson's tests:—"Notwithstanding the confidence we feel in our eminent colleague, it is impossible for us to accept his figures without making one important observation. Dr. Silvanus Thompson estimates at 9d. or 10d. (90 centimes to 1 franc) the price of the Board of Trade unit. But we see, according to the figures published, that there is consumed about 1 kilogramme of zinc, the price of which would not be less than 65 centimes ( $6\frac{1}{2}$ d.). It follows from this that the *special liquid* in which there must be sufficient active matter to dissolve this zinc costs only 35 centimes ( $3\frac{1}{2}$ d.). This seems very improbable, not to say impossible. We always receive with a certain amount of distrust these marvellous batteries that are said to supply electrical energy cheaper than the central distributing stations, and M. Vaughan-Sherrin's special liquid will not make us change our opinion, notwithstanding Prof. Silvanus Thompson's figures, and we are reminded of our great fabulist: '*Ce liquide spécial ne nous dit rien qui vaille,*' and also of the poet: '*Hélas! que j'en ai vu mourir, de jeunes piles.*' We hope our readers will pardon the liberty we have taken with the text, in consideration of our willingness to apologise when the miraculous—we beg pardon, the special liquid—becomes known to us."

Telephone Working.  
AT a recent paper read before the National Exchange Association, Detroit, America, a rather lengthy description was given by Mr. Carty of the "Bridging Bells" system of working telephone lines. The speaker seemed to be quite unaware that the method described had been for many years in use on the telephone systems worked by the Post Office in this country, and all details in connection with the same carefully worked out. A description of it is given in "The Telephone," by Preece and Maier.

The Electropathic Quack Again.  
MR. HARNESS, with his electropathic appliances, is once more to the front. This time it is that staunch conservative evening paper, the *St. James's Gazette*, that he has succeeded in beguiling. We had always imagined that the etiquette of respectable journalism had drawn a broad distinction between the space allotted for subject matter and advertisements, so that the public in reading should not be unwittingly drawn into perusing matter which they believe to be general news but which they find to be "puff," pure and simple. The *St. James's Gazette*, however, appears to have recognised no such difference, but in a recent number has allowed the prominent position which the journal has justly won as a temperate leading evening paper, to be made the means of furthering the ends of Mr. C. B. Harness. Thus, in the No. for October 6th, on the last sheet we find a whole column of matter printed in article type and arranged and headed in article form, solely devoted to the puffing of Mr. Harness's so-called electrical appliances. The editors of daily papers cannot be expected, of course, to be skilled electricians, and mistakes of an exceedingly absurd character with reference to the science are sometimes inevitable, but considering the wide-spread and known existence of quackery, especially of the electrical description, it is hardly too much to expect that reasonable care should be taken to protect the unsuspecting public from confounding advertisement with news items.

Copper.  
IN the lectures recently concluded at the Mining Exhibition, some interesting statements were made on the subject of copper. The lecturer on "Mining and Minerals in South Australia," spoke of the first discovery in that country made in 1842, viz., the Kapunda Copper Mine, which produced thousands of tons of ore, at the same time greatly benefitting the colony and bringing it into favourable notice as an important mineral country. Other discoveries quickly followed, and the Burra Burra Mine, which once supported an immense population, marked a new era in the history in copper mining in South Australia. The total amount paid in dividends in this concern was £800,000. After being worked by the original owners for some years, the mine was sold to a new company; but during the past two or three years the mines had not been worked, owing in some degree to the low price of copper, and also to the fact that the deposit then being worked apparently became exhausted. For many years the average yield was from 10,000 to 13,000 tons of ore, averaging 22 to 23 per cent. of copper. Other mines were opened, though the output was less, and many of these were now closed, but it was said that they would be shortly reopened, a fact which the lecturer urged would still further decrease the price of copper. Referring to the great "boom" in copper in 1861, which

caused the output to be tremendous, he said that at that period there were working in one mine alone 1,600 men. Copper mining has so far affected the wealth of the country in as much as two mines, opened about 1870, had down to the present time proved of value to the colony to the extent of seven million pounds. The fourth lecture, delivered by Mr. J. C. Gordon Sprigg, dealt with the mining industry in South Africa, in which copper had always played a strong part. Here was situate the Namaqualand copper fields, from which 400,000 tons had been sent to England.

Lamp Candle-powers.  
WE publish in our Correspondence Columns a very interesting letter on this subject, to which is attached a valuable table of tests, the like of which, we think, has not hitherto been published. These experiments were carried out by Mr. W. W. Melhuish, the chief-engineer of the station, and we have examined the lamp curves from which the figures have been taken. The superiority of the first-mentioned lamp will not fail to attract attention, but possibly some of the others have been much improved during the two years which has elapsed since the data was obtained.

Cable Laying and Maintenance.  
ONE of the clauses in contracts between submarine cable companies and manufacturers constitutes a grievance which, we expect, both parties would gladly see abolished. We refer to the final operation connected with cable submerging, the conditions of which are generally set out as follows:—"The cable shall be maintained and tested for thirty (consecutive) days after the completion of the laying at the sole risk of the contractors." If the cable is likely to go wrong through any inherent defect in its construction, it would show faulty in less time than thirty days. This clause has become customary because nobody has apparently hitherto attempted to show that it is unnecessary; it is a costly business for both manufacturers and owners of cables, and the sooner the maintenance clause is limited to a week, or even less, so much the better for everybody concerned. The public would not only be enabled to send messages at an earlier date, but the cable companies would naturally save vast sums of money which of course the contractors allow for in their estimates, and their shareholders would thus derive extra benefit. Possibly the thirty days' guarantee might have been advantageous in times gone by when cable manufacture and testing were not thoroughly understood, but to-day it is but the perpetuation of an old, and now more or less useless custom, and should, therefore, be either abandoned altogether or so modified as to meet the requirements of modern practice.

Distance of Telephone Working.  
IN the article on "Telephonic Specific Inductive Capacity," by Mr. W. W. Jacques, which we publish in our present issue, it is stated that the good speaking limit, or "K R," over a telephone line with a Blake transmitter is 2,000 and with a Hunnings transmitter 4,500. These figures differ materially from those obtained, as the result of numerous experiments, both on aerial lines, underground wires, and artificial cables (combinations of condensers and resistance coils) in this country. The average good speaking limit on overhead copper wires is found to be 10,000, on cables and underground wires 8,000, and on overhead iron wires 5,000, but then a Gower-Bell instrument was used.

## ELECTRICAL OSCILLATIONS IN AIR.\*

By JOHN TROWBRIDGE and W. C. SABINE.

THE experiments of Hertz on electrical waves have opened a wide field for investigation in electromagnetism. The qualitative results of Henry and of Feddersen have been expressed in a quantitative manner by Sir William Thomson. Hertz, collecting together the results of previous observers, and reasoning upon the factors in the formula of Sir W. Thomson, which expresses a relation between the capacity of a Leyden jar and the self-induction of the circuit through which this jar is discharged, has detected wave-motion with its nodal points and ventral segments, on a wire over which electrical oscillations take place.

Hertz has also pointed out that the experimental results confirm Maxwell's theory, that light and heat are electromagnetic phenomena, and that all energy comes to us from the sun in electrical pulsations.

There can be no question of the phenomena of so-called resonance discovered by Hertz. Roughly speaking, the results obtained by Hertz resonators

satisfy the formula  $t = \frac{2\pi}{v} \sqrt{LC}$  in which  $t$  is the

period of the electrical oscillations,  $L$  is the inductance of the circuit, and  $C$  is the capacity of the jar, or that of the terminals between which the electrical discharge takes place.

Prof. J. J. Thomson has based a method of measuring the capacities of dielectrics upon this formula and upon Hertz's work †.

The researches of Feddersen upon electrical oscillations ‡ were more quantitative than those of Joseph Henry § and Lorenz §, by his repetition of Feddersen's results, and by his mathematical analysis of them, apparently gave subsequent observers a solid basis for calculation.

The results of Feddersen and of Lorenz were obtained by photography. An image of the electric spark drawn out by means of a revolving mirror was photographed, and the distances between the successive oscillations, shown by dark bands on the photograph, were measured. Lorenz assumed the ratio between the electrostatic units and the electromagnetic units,  $v = 300 \times 10^6$  metre, as that of the velocity of light; and by means of

the formula  $t = \frac{2\pi}{v} \sqrt{LC}$  obtained a satisfactory

agreement between the result of experiment and the theory. He showed, apparently, that a certain lack of agreement between theory and experiment, which Feddersen had noticed, was due to taking the dielectric constant of glass too small.

It will be noticed that the method of Feddersen, by means of which the electrical oscillations are photographed, apparently affords an accurate method of determining  $v$ . For the factors  $L$  and  $C$  occur under the square root, and the percentage errors of determination of  $L$  and  $C$ , being under the square, are halved. Lorenz did not repeat the entire work of Feddersen, but only obtained a sufficient number of photographs—taken under definite conditions in regard to capacity and inductance of the circuit—in order to measure  $t$ , the time of oscillation. The accuracy of the results which can be obtained for  $v$  depends upon the limits of accuracy of the measurements of the photographs, and of the determinations of the dielectric capacity for oscillatory charges.

In reasoning upon the mode of electrical oscillations in dielectrics, it occurred to us that the medium of the dielectric must greatly influence the result. At the instant the electrical oscillations occur, the glass of the

Leyden jar is subjected to a strain which is more or less periodic. It is not probable that the capacity of a condenser is the same for rapid charges and discharges as for slow ones, and the measurements of capacity by the ordinary slow methods form no criterion of the capacity of glass under electrical influences which last but three millionths of a second. We therefore concluded to employ an air condenser instead of one of glass, in order to detect, if possible, the effect of the medium of the dielectric upon electrical oscillations. In order to obtain sufficient capacity for a suitable spark, we were obliged to use the cylindrical form of condenser. The first condenser we employed was made of sheet zinc and consisted of 19 coaxial cylinders. The inner cylinder had a diameter of 15.1 centim., and the outer one of 60.4; the height of the cylinders was 92 centim.

The capacity was computed from the formula

$$C = \frac{1}{2} \frac{l}{\log \frac{b}{a}};$$

in which  $l$  is the height, and  $b$  and  $a$  are radii.

A correction for the ends was made as follows:—The radius of curvature of the boundary of the cylindrical plates was considered so large in comparison with the distance between them that the boundary was treated approximately as a straight line. We may consider that each zinc cylinder constituted a plate between infinite imaginary planes which were at zero potential, these planes being equipotential surfaces. The zinc cylinder was supposed to have its area extended by a strip of uniform breadth around its boundary, and the surface density was assumed to be the same on the extended plate as on the parts not near the boundary. Following Maxwell (Vol. I. Section 196), we have

$$\frac{B}{\pi} \log_e 2 \cos \frac{\pi \beta}{B} \text{ for the correction for length.}$$

$B = a - b =$  distance between cylinders.

$\beta =$  thickness of cylinder.

$l =$  height of cylinder.

This air condenser was connected with a circuit of parallel wires, which was carefully strung by means of silk thread through the centre of a large unoccupied room. The length of this circuit was about 50 feet. It returned upon itself to the sparking terminal of the air condenser. The jar was charged by a Holtz machine, which worked fairly well under all conditions of the atmosphere. The revolving mirror was a plane one,  $4 \times 5$  inches, silvered upon the front face. It revolved upon a horizontal axis with an average speed of 3,000 revolutions per minute. The frame which carried the mirror bore also a brass arm provided with a minute brush, which rubbed upon a brass sector let into a large disc of ebonite. When the brush rested upon this brass disc the electrical charge could pass to two terminals of tin, between which the discharge took place. A concave silvered glass mirror, of 313 centim. radius and 16.5 centim. aperture, placed at a distance of 230 centim. from the spark, received the image of the spark and reflected it back to the revolving mirror. From the revolving mirror the image was reflected to a photographic plate, which was at a distance of 259.7 centim. from the rotating mirror.

The adoption of a plane revolving mirror, and a stationary concave mirror of long focus, enabled us to place the photographic plate at a distance from the revolving apparatus, and therefore to employ less speed for the revolving mirror. There was no sensible aberration of the image. Great care was taken to balance the mirror. Its large size and weight made it very important, on account of the danger of the apparatus flying apart, that it should revolve with uniformity. The axis of the mirror was placed horizontally. This precaution proved to be a wise one, for twice during the course of the many runs which were made the mirror flew into pieces; the excursions of the fragments, however, were confined to a vertical plane. This liability to accident is perhaps inherent in a method which employs a large plane mirror. The increased

\* From the Proceedings of the American Academy of Arts and Sciences. Advance proof communicated by the authors to the *Phil. Mag.*, October, 1890.

† Proceedings of the Royal Society, June 20th, 1889.

‡ Poggendorff's *Annalen*, vol. ciii., p. 69 (1858); vol. cviii., p. 497 (1859); vol. cxii., p. 452 (1861); vol. cxiii., p. 437 (1861); vol. cxv., p. 336 (1862); vol. cxvi., p. 132 (1862).

§ Wiedemann's *Annalen*, vol. vii., p. 161 (1879).

amount of light which results from the use of a large mirror, however, forms a valuable compensation. The revolving mirror was driven by a gas engine.

In order to determine the speed of the mirror at the instant the spark passed, the following apparatus was devised. The same shaft which carried the revolving mirror also carried a brass cylinder 5 centim. in diameter and 21 centim. long. This cylinder was covered at each trial with paper which was coated with lampblack. A stylus moving along a stationary rod beside the shaft could be made to draw a spiral upon the revolving cylinder. One terminal of a Ruhmkorff coil was connected with the brass cylinder, and the other with the stylus. A second pendulum was made to break the circuit of the primary of the Ruhmkorff coil at intervals of one second, and at the middle point of its swing. When the stylus was drawn along the stationary rod which served to guide it, it was made to release automatically at the beginning of the second another pendulum held up by an electro-magnet. This latter pendulum, at the middle of its swing, discharged the air condenser through the inductance circuit at the instant that the mirror was in a suitable position to reflect the image of the electric spark into the photographic camera. While the stylus was being drawn upon the revolving cylinder, the spark from the Ruhmkorff coil left its trace upon the blackened paper. The record on the chronograph consisted of a strongly marked spiral line of over fifty turns. The two sparks from the Ruhmkorff coil left their trace upon the blackened paper as spires, which therefore measured the number of revolutions of the cylinder between the swings of the pendulum, and thus gave the rate at which the mirror was revolving. The chronograph record enabled us to measure the time to  $\frac{1}{3000}$ th of a second.

In any operation which requires that an electrical spark should make a record upon a disc or cylinder revolving at great speed, a large Ruhmkorff coil and a strong battery are necessary, especially if the primary circuit of the Ruhmkorff coil is broken by a pendulum. With the ordinary automatic break, such as is commonly employed upon induction coils, the failure of a single break is unimportant. If, however, a single break fails when a pendulum break is employed, the record of the experiment is an imperfect one. An excess of battery power and a large battery are therefore necessary. A metallic breakpiece also was found to be more inconstant for our purposes than a mercury break.

It was found that a certain simplicity of contrivance was necessary in the method of discharging the air condenser through the inductance circuit. No arm connected with the revolving mirror could be trusted to break or make an electrical circuit by throwing in or out any form of switch. The great speed at which it revolved broke all arrangements which were tried. By placing a short stiff brush of minute size upon the end of the flying terminal connected with the revolving mirror, and allowing this brush to rub against a brass plate set in an ebonite circle of 41 centim. in diameter, constancy of action was secured.

In order to obtain the same difference of potential at each run, experiments were first made with various forms of unit jars and pith-ball electrometers. These devices were speedily given up in favour of a simple balance electrometer. One of the pans of a delicate balance was replaced by a metallic disc. A similar disc, which was stationary, was placed immediately below the movable one. By properly weighting the remaining balance pan great delicacy and range of indication were obtained. This apparatus constitutes, in fact, an absolute electrometer. A suitable guard ring can be placed around the movable disc.

When the air condenser had been charged to a definite potential, the movable disc of the electrometer closed an electrical circuit in which was included an electrical bell. The observer stationed at the chronograph, at the instant he heard the bell, drew the carriage connected with the stylus along the guides which kept the stylus on the blackened cylinder.

Calling  $L$  the coefficient of self induction, we have

$$\frac{L}{l} = 2 \log \frac{b^2}{a^2} + 1^*$$

in which  $l$  is the length of conductors contained between two parallel planes;  $b$  the distance apart of the conductors;  $a$  the radius of wires.

In our case the effect of the ends was found to be inappreciable. The induction due to the ends can be calculated by the repeated employment of the formulæ for geometric mean distance† for two lines whose directions intersect at right angles.

Lord Rayleigh has given the following formula for inductance under rapid oscillations:—

$$L' = l \left( A + \sqrt{\frac{\mu R}{2 \rho l}} \right);$$

in which  $A$  is a constant, depending on form of circuit;

$\mu$  is permeability;  $R$  is resistance;  $\rho = \frac{2\pi}{t}$ , where  $t$  is time of oscillation;  $l$  is length to and fro of inductance circuit.

The final value of  $L'$  for our case is  $L' = 39,697$ .

The radius of the wire employed was  $a = .0501$  cm.

The length was measured in three sections:—

No. 1, length	1197.0	cm., distance between wires	$b_1 = 31.55$ cm.
No. 2, „	281.0	„ „	„ $b_2 = 16.1$ cm.
No. 3, „	103.0	„ „	„ $b_3 = 11.3$ cm.

The ohmic resistance of the wires was  $.742 \times 10^9$  for direct current, and  $1.54 \times 10^9$  for alternating currents of period  $t = .0000031$ .

The difficulty in the process of photographing the spark consisted in discharging the air condenser through the induction circuit at the instant the revolving mirror was in a position to reflect the image of the spark to the photographic plate. The terminal connected with the revolving mirror, which allowed the electrical discharge to pass when the mirror was in the desired position, had to be adjusted with extreme care. The speed of the image at the photographic plate was about 1 mile per second.

The photographs were measured by means of a dividing engine. At first an objective of low power was used on the microscope of the dividing engine. It was found, however, that a simple cross hair, unaided by a lens, moving directly against the negative, was better than any eyepiece. Measurements were made of the intervals between the electrical oscillations at both terminals.

In later experiments a smaller air condenser was employed, for reasons which will appear in the conclusions of our paper.

A summary of the details and dimensions employed is given herewith.

Small air condenser (No. 2), cylindrical.

19 zinc cylinders.

Height 30.47 centim.

Diameter of inner cylinder 7.60 centim.

Diameter of outer cylinder 25.95 centim.

Average distance apart .5 centim.

Capacity (geometric) 5317.9 absolute units—corrected for the capacity of ends.

Capacity of wire, 200.

Self-induction in three sections, radius .0501.

1. Length, 1197.

Distance apart of parallel wires, 31.55.

2. Length, 281.

Distance apart, 16.10.

3. Length, 103.

Distance apart, 11.3

For alternations of slow period.

Ohmic resistance, .742.

Self-induction, 41,090.

Theoretical time with these values, .00000310 sec.

For alterations of period, .00000310 sec.

Ohmic resistance, 1.54.

Self-induction, 39,700.

Theoretical time, .00000304.

\* Maxwell, § 685, vol. ii.

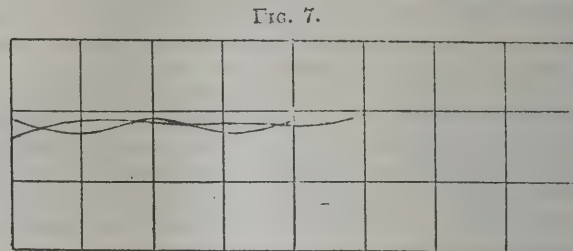
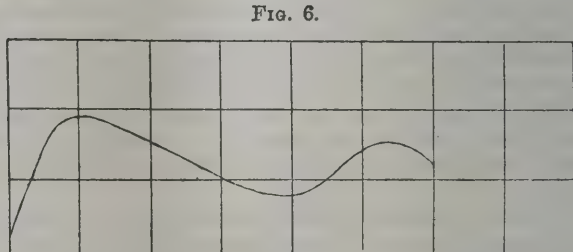
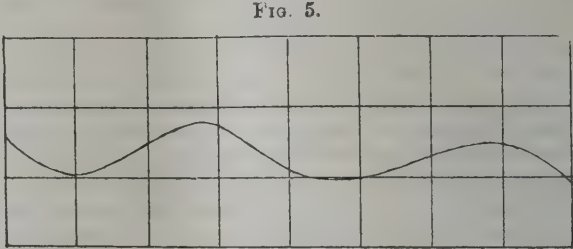
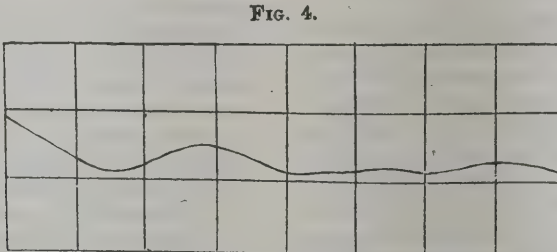
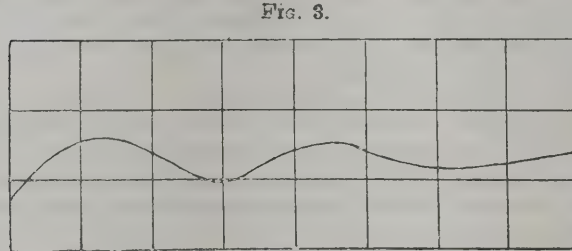
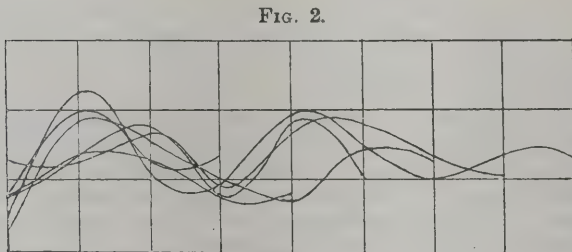
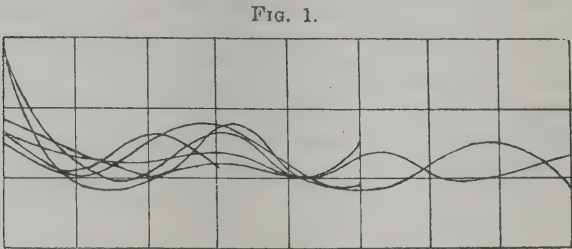
† Ibid. § 692, vol. ii.

Distance from spark to concave mirror, 230 centim.  
Distance from rotating mirror to negative, 259·7 centim.  
Sparking distance, ·23 centim.  
The following is a sample record (see figs. 5 and 6).  
Each negative was measured three or more times, and the mean taken. The lengths are given in centimetres. The last line is the time in millionths of a second.

Right Terminal.									
·289	·541	·561	·598	·552	·511	·544	·560		
·295	·528	·560	·595	·542	·542	·550	·585	·492	
·290	·528	·582	·602	·518	·538	·550	·570	·532	
·292	·518	·585	·592	·540					
·291	·529	·572	·597	·540	·528	·549	·572	·512	
1·65	3·00	3·24	3·38	3·06	3·00	3·11	3·24	2·90	

The following table gives the values in millionths of a second of the successive oscillations on six negatives taken with small air condenser under the conditions given on the preceding page. The first on the right terminal is a half-oscillation. The rest are double oscillations.

Right Terminal.									
1·65	3·00	3·24	3·38	3·06	2·91	3·11	3·24	2·90	
1·68	3·22	2·99	3·35	3·03	2·97				
1·90	3·11	3·01	3·31	3·00	3·29				
1·95	2·95	3·00	3·08	3·06	3·20	3·03	3·03	3·16	
1·62	3·01	3·34	3·04						
1·64	3·18	3·14	3·18	3·03					
1·74	3·08	3·12	3·22	3·04	3·09	3·07	3·13	3·03	



Left Terminal.						
·461	·611	·582	·522	·508	·551	·554
·461	·609	·567	·543	·500	·585	·556
·462	·607	·574	·532	·502	·570	·542
·462	·609	·574	·532	·503	·569	·551
2·62	3·45	3·25	3·01	2·85	3·22	3·12

Number of revolutions per second, 54·06.  
Length of spark, ·23 centim.

Left Terminal.						
2·62	3·45	3·25	3·01	2·85	3·22	3·12
2·89	3·50	3·08	3·21			
3·11	3·12	3·30	2·96	3·35	3·39	3·16
2·75	3·63	3·02	2·97	3·48	3·22	3·00
2·84	3·19	3·36	2·89	3·41	3·00	
2·88	3·19	3·13	2·90	2·96		
2·85	3·39	3·19	2·99	3·21	3·21	3·09
						3·12
						3·19

The discharge of a glass Leyden jar gave the following values, when reduced to seconds, different lengths of spark being used.

Length of spark.	Terminal.	Time of successive oscillations.						
·4 centim.	{ Right	1·66	3·22	3·30	3·44			
	{ Left	3·33	3·37	3·30	3·36			
1·3 "	{ Right	1·71	3·32	3·45	3·37	3·42		
	{ Left	3·30	3·43	3·42	3·43	3·42	3·50	

Fig. 7 shows that the length of the spark exerts an inappreciable effect,

The values for the different negatives are plotted in fig. 1, 2 ; the mean values, in figs. 3, 4. The time of the first half-oscillation was doubled in plotting. On each ordinate is plotted the time of one oscillation—on the first ordinate the time of the first oscillation, on the second the time of the second. It should be noted that the curved lines are meaningless, except where they cross the vertical ordinates, serving merely to connect the points belonging to one negative.  
The difference in the time of oscillations cannot be

explained by the vibration of the discharging arm lengthening and shortening the sparking distance, since this would necessitate a vibration frequency of 100,000 per second, and an amplitude of at least one millimetre; a velocity and momentum impossible for the apparatus either to acquire or endure. This cause also would tend to make the variation range equally above and below the calculated value as the sparking distance increased or diminished.

Another explanation may be sought in the varying ohmic resistance of the path of the spark, although this explanation is inadequate to explain the whole effect. In order to test it, a long (1.3 centim.) and short (.4 centim.) spark were taken from a glass Leyden jar (see fig. 7). Not only could no appreciable difference between the two plates be detected, but there was no variation in the time of successive oscillations.

In regard to the measurement of the negatives on the dividing engine, the following points may be worthy of mention. At the time the measurements were made, it was expected that the sparks from the glass condenser would show the variations, and that the air condenser would give the constant and theoretical period of oscillation. The reverse of this appeared when the results of the measurements were reduced. Moreover, the measurements were made by a run of the dividing engine from one end of the negative to the other; so that if an error was made in the setting of the cross hair on the image of one discharge—for example, making the measurement of that oscillation large—a corresponding amount would be deducted from the measurement of the next oscillation. The result of this would be that if the apparent variations were due to errors in measurement, the periods of discharge would be alternately large and small, or at least as often and as far below the theoretical value as above it. But this is conspicuously not the case.

A consideration of the curves which represent our results shows that with quick oscillations which result from the employment of a small air condenser, the air dielectric did not have time to recover completely, in the time of one oscillation, from the strain to which it was subjected. With the larger air condenser, the oscillations being slower, more time was given for this recovery, and hence the periodicity which we have discovered was not so marked. It seems, therefore, that not only should an electrical resonator be turned for capacity and self-induction, but also for a certain periodicity of strain in the dielectric.

In the case of glass, we should not expect to obtain evidence of this periodical recovery from a quick strain, since it is well known that the recovery from strain is so slow that the discharge from a Leyden jar is incomplete after a discharge lasting a second. The curve we give for glass (fig. 7) shows that this periodical recovery is too slow to manifest itself during the time of quick oscillation.

It is perhaps unnecessary to call attention to the fact that the capacity of a dielectric for rapid discharges is very different from its capacity for slow discharges. In the paper of Lorenz, already cited, the value of the dielectric capacity of glass was determined by slow methods, and used to test an equation in which the capacity of glass appears under very rapid charging and discharging.

Boltzman\* and Klemencint† have experimented on the specific inductive capacity of gases and vapours, and it is seen from their results that the agreement between the square root of the capacities of the simple gases and  $\mu$ , the index of refraction for light of these gases, is quite close, as is demanded by Maxwell's electromagnetic theory of light. A marked difference, however, was found to exist in the case of more complicated molecules—sulphurous acid, or ethyl bromide, for instance. It is probable that the changes of specific capacity of heterogeneous media under rapidly alternating forces constitute an important factor in consider-

ing the possible agreement between Maxwell's theory of light and the results of experiment.

In order to see if an intense magnetic field could modify the transmission of electrical waves through a dielectric, the following experiment was tried. A glass Leyden jar, 2.5 centim. in diameter and 28 centim. in height, connected with our inductance circuit, was placed inside a coil consisting of 728 windings of large wire. The outer and inner radii of this coil were 27.7 centim. and 34 centim. Its height was 40.5 centim. The magnetic field in this coil was supplied by a Gramme machine, which gave a current through the coil of approximately 30 amperes. It was expected that a certain amount of the energy spent in producing the electrical waves would be consumed in a reaction on the magnetic field. The total duration of the electrical discharge did not appear to be notably affected by the magnetic field. Certain experiments seemed to show a decrease in the total number of electrical oscillations. A large number of experiments will be necessary to decide upon the effect of a magnetic field upon the passage of electrical waves through a dielectric. The difficulty of obtaining an electrical discharge under the same difference of potential made the experiment an extremely difficult one. The method seems to us to promise a discovery of Maxwell's displacement currents in dielectrics; and we are therefore continuing our researches in this direction with a modified form of apparatus.

#### Conclusion.

1. The electrical oscillations in the air between the plates of an air condenser show a periodicity extending through the entire range of oscillations. We believe that this periodicity is the analogue of the phenomenon of hysteresis in magnetism. A certain amount of the energy of the electrical discharge is spent in overcoming the dielectric viscosity of the air and in straining the air dielectric. This strain is not immediately released in unison with the electrical surging.

2. The discussion of our entire results shows unmistakably that electrical oscillations in air are not represented fully by the theoretical equations employed by Hertz. Since the latter writer has taken the term *resonance* from the subject of acoustics, and has given it a new significance in relation to electrical waves, we are tempted to draw also an analogy from the subject of sound. Laplace showed that the discrepancy between the value for the velocity of sound in air calculated from the theoretical equation, and that obtained by experiment, was due to a transformation of energy in heating and cooling the air during the passage of the sound wave. Our experiments on the transmission of electrical waves through the air show also that the values calculated from the theoretical equation do not agree with the experimental values. The discrepancy, we believe, can be explained also by a consideration of the transformation of energy in the dielectric.

3. The periodicity which we have studied is most manifest when the variable capacity of the air condenser bears a suitable relation to the time of the electrical surging.

4. The electrical waves are apparently unaffected by passing through glass which is placed in an intense magnetic field, the direction of the electrical strain being perpendicular to that of the magnetic strain. The displacement currents of Maxwell in this case do not appear to affect the time of electrical surging. This conclusion, however, may be modified by experiments which we shall try on a more extended scale.

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**Telephone License.**—We are informed that the Secretary of the Post Office has intimated to Mr. A. Erskine Muirhead, Cart Forge, Glasgow, that he will grant him a license for telephonic communication. This, he claims, will enable him to make a public trial of the French telephones, which was refused him by the National Telephone Company.

\* Pogg. Ann. cli. p. 403 (1875).

† Abstract of Journal of the Society of Telegraph Engineers (1886), p. 108.

TELEPHONIC SPECIFIC INDUCTIVE  
CAPACITY.\*

By WILLIAM W. JACQUES,

Electrician of the American Bell Telephone Company.

IN a paper on "The Construction of Telephone Circuits," read before the American Academy of Arts and Sciences on the 15th of June, 1887, the writer of the present article pointed out "that the readiness with which telephonic conversation may be carried on over any circuit, whether made up of cables or pole lines, or both, depends:—

"1. On the total electrical resistance of the circuit joining together the two stations.

"2. On the total electrostatic capacity of this circuit."

And the general rule was laid down:—"No matter what may be the distance between two points, good business conversation may be carried on between them, provided they be connected by a pole line or cable, or both, the product of whose total resistance by its total capacity is less than 2,000, if transmitters of the Blake type be used, and less than 4,500 if transmitters of the Hunnings type be used."

This rule was enunciated as the result of an extended series of experiments carried out in England, France, Germany, and the United States on pole lines, cables, and mixed pole and cable lines, varying widely in mechanical and electrical dimensions.

The same law, only applied to the transmission of signals through submarine cables, had been previously worked out mathematically by Sir William Thomson, and amply confirmed by experience, so that to-day there can be no doubt of its truthfulness. It is evident, therefore, that in the construction of a telephone line, it is desirable to reduce both the *resistance* and the *capacity* to a minimum.

In a pole line, since the wire is suspended high above the earth, the capacity is always small, and the resistance is the factor that we must try to keep down. In cable lines, however, where the conductor is necessarily brought near to other conductors, or a metal shield, or the earth, the capacity becomes quite an important factor to be respected. In lines made up, as is most generally the case, of a comparatively short section of cable and a larger section of iron pole wire, the capacity of the cable becomes pre-eminently the factor to be respected; for, since the limit of conversation is here determined by the product of the capacity of the cable and the resistance of the whole line, a small percentage of saving in the capacity of the cable gives an enormous gain in the readiness with which conversation may be carried on over the line.

It becomes of vital importance, therefore, to choose an insulating material for telephone cables of low specific inductive capacity. Further than this, since it is well known (Gordon's "Electricity and Magnetism," Chap. XI.) that the specific inductive capacity of any insulating material, and consequently the capacity of any cable insulated with it, is very different for telephone currents from what it is for telegraph currents, because the charge and discharge take place so much more frequently, we may say that it is of vital importance to choose an insulating material of low "telephonic specific inductive capacity," using this expression in contradistinction to "telegraphic specific inductive capacity," by which we mean the values measured in the old-fashioned way.

In the *Proceedings* of the American Academy for December 11th, 1889, Messrs. Safford and Holman, two graduates of the Massachusetts Institute of Technology, in the Department of Electrical Engineering, have published the following table of telephonic specific inductive capacity of various insulators used in cable construction. This table is a result of an elaborate and careful research undertaken by them.

TABLE OF SPECIFIC INDUCTIVE CAPACITIES,  
MEASURED BY TELEPHONE CURRENTS.

1. Petroleum	...	...	...	...	1.6
2. Solid paraffin	...	...	...	...	2.0
3. Cotton saturated with paraffin in vacuum	...	...	...	...	2.0
4. Cotton boiled in paraffin	...	...	...	...	2.6
5. India-rubber	...	...	...	...	3.7
6. Artificial gutta-percha	...	...	...	...	3.9
7. Gutta-percha	...	...	...	...	4.2
8. Glass	...	...	...	...	4.6
9. Water	...	...	...	...	6.3

Realising that these results were of great practical importance in the construction of telephone cables, the writer has repeated the experiments of Messrs. Safford and Holman with entirely concordant results.

Let us see some of the conclusions we are obliged to draw from the data thus furnished, and then, in order to confirm these conclusions, we will describe some further experiments in this line.

I. The specific inductive capacity of any insulator used in the construction of telephone cables, and, consequently, the actual electrostatic capacity of any given telephone cable, ought to be measured with charges and discharges of telephonic frequency, and not by the old-fashioned method of measuring capacities by slow charge and discharge. This last is of no value, while the telephonic capacity is of vital importance.

II. The presence of water in an insulating material greatly increases its telephonic specific inductive capacity. An inspection of this table shows that, so far as capacity is concerned, petroleum is the best substance to be used, and doubtless this would be the case were it possible to keep it free from water, but water, we see from the table, has a specific inductive capacity of 6.3, so that its presence in the petroleum raises the capacity from the lowest to the highest in the list.

This observation is borne out by actual experience with cable No. 1 in telephony. When new, and the petroleum dry, it works excellently; but as water finds its way in, the cable rapidly loses its efficiency for telephonic work.

This action of the water is quite different from its action as a *conductor* to produce leakage, for the loss of electricity due to leakage in such a cable that has lost its efficiency from the presence of moisture, is entirely insufficient to account for the deterioration.

So, too, in the cable, No. 4, the presence of moisture exercises a detrimental effect on the power of the cable to transmit telephonic currents, and increases the inductive cross-talk to a degree that cannot be accounted for by the diminished insulation resistance.

It is proposed to show later that the presence of moisture in a lead covered cable, does actually increase very greatly its telephonic capacity, and, consequently, both the retardation and cross-talk.

III. Next to petroleum, solid paraffin is seen to be the best substance to use; but on account of mechanical difficulties it has never been found practicable to coat wires directly with solid paraffin.

If the wires are wound with cotton and then boiled in paraffin, as they are in making cable No. 4, the specific inductive capacity is raised to 2.6, an increase of 30 per cent., which, we have seen, is a very great detriment.

If, however, the wires are wound with cotton, and the air and moisture removed by the aid of heat and a vacuum, and they are then boiled in paraffin, from which the air and moisture have also been removed by heat and vacuum, the specific inductive capacity again falls to 2.0, which is the same as that of solid paraffin. This is the process used in preparing the cable No. 3.

It is probable that the inferiority of cable No. 4, as compared with No. 3, is due largely to the moisture retained in the cotton, which we have seen has a capacity of 6.3.

Leaving the paraffin cables, rubber is the next best, then gutta-percha, and poorest of all is glass; but all of these latter substances have so high a specific inductive capacity as to entirely unfit them for telephonic work.

It now becomes desirable to put this information in

\* New York Electrical Engineer.

more available form, for the use of those upon whom the selection of the best cables for use in telephone construction devolves.

Accordingly, I have given in the following table, first, the telegraphic capacity; second, the calculated telephonic capacity; and third, the measured telephonic capacity of one mile each of cables Nos. 3, 4, 5 and 7, all constructed on the dimensions of the "conference standard."

The measurements of the cables Nos. 3 and 4 were made on cables actually constructed in accordance with the requirements of the conference standard. Those of the rubber and gutta-percha cables were made on cables of a different specification, but reduced to the conference standard by well known and accurate methods of calculation.

*Capacity of One Mile of Conference Standard Cable,  
in Microfarads.*

	Measured tele- graphic capacity.	Calculated tele- phonic capacity.	Measured tele- phonic capacity.
Cable No. 3 .....	·18	·18	·18
" " 4 .....	·19	·24	·26
" " 5 .....	·27	·30	·30
" " 7 .....	·40	·40	·40

In order to show how great a difference in the practical working of a line this difference in telephonic capacity makes, let us assume a conversation to be carried on between two subscribers, connected by five miles of conference cable, and 40 miles of No. 12 iron pole wire.

Let us first suppose cable No. 3 of the conference specification be used.

Resistance 40 miles No. 12 iron wire = 1,184 ohms.

" 5 " cable ... = 175 "

Total line resistance ... = 1,359 "

Capacity 40 miles No. 12 iron  
wire (30-foot poles), = ·48 microfarad.

Capacity 5 miles Nos. 3 cable = ·90 "

Total line capacity ... = 1·38 "

Product of total resistance and capacity (1,359 × 1·38) = 1,875, which product, being considerably less than 2,000, shows us that conversation could easily be carried on over such a line with Blake transmitters.

Let us next suppose cable No. 4 of the conference specification to be used.

Resistance 40 miles No. 12 iron wire = 1,184 ohms.

" 5 " cable ... = 175 "

Total line resistance ... = 1,359 "

Capacity 40 miles No. 12 iron  
wire (30-foot poles), = ·48 microfarad.

Capacity 5 miles cable No. 4 = 1·30 "

Total line capacity ... = 1·78 "

Product of total resistance and total capacity (1,359 × 1·78) = 2,419, which product is considerably above 2,000, and good commercial conversation could not be carried on with Blake transmitters.

## THE TELEGRAPH DEPARTMENT OF QUEENSLAND.

THE Report of the Superintendent of Electric Telegraphs, Mr. A. F. Matveieff, concerning the telegraph branch for the year 1889, is briefly as follows:—

Since the last annual report, May 1st, 1889, the total mileage of extensions completed, dismantled lines, &c., deducted, amounts to 473 miles of line, 521 miles of wire. Several hundred miles are in course of construction. There are now 9,662½ miles of line, and 17,193 miles of wire open for public business.

At the close of 1889 there were 343 stations in daily

operation, and 721 officers employed, including those holding appointments in other departments, but exclusive of assistants at country stations (officers' wives), and construction parties. Since April 26th, 1889, 17 new stations have been opened, and one station closed, and 14 official stations added.

The twelve months which ended on March 31st last will long be remembered by the officers of the telegraph branch of the post and telegraph department as a period of unprecedented floods, damage to lines, delays to business, and difficulty and danger in many instances in restoring communication and effecting repairs. The total number of interruptions of all kinds in the southern and western districts was 1,007, caused principally by crosses with telephone wires, faults in railway offices, rotten trees falling and trees blown on lines, crosses caused by high winds, pins broken, insulators and brackets damaged; trees felled on lines by road parties, railway contractors, selectors, and others; damages by lightning (17 only). Also a few by large birds coming in contact with the wires; highly laden teams catching wires; hoop iron, fencing wire, tie wire, and fine wire hanging on main wires, in some instances occasioning serious interruptions before found (many of these, it is even feared, were purposely caused by evil intentioned people); blasting operations, land slips, &c., &c. An interruption was also caused by a large snake twisted in the wires, and another by flying foxes.

The expenditure on maintenance and repairs for 1889 was as follows:—Southern and Western districts, £5,473 7s.; Northern district, £3,769 13s. 11d.; total, £9,243 0s. 11d.

So far as interruptions to the cables are concerned, this has been the most unfortunate year experienced. On the 3rd of May, 1889, the cable at Flat-top Island was broken by a steamer's anchor, and hardly had the officer sent to repair it returned to Brisbane, when another misfortune of the kind occurred. Its position was then altered, and about a knot of new cable inserted. It worked well till January of this year, when it was again damaged by the heavy gale blowing at Mackay in that month; this necessitated another repairing job and the expenditure of 450 fathoms of new material. In May, last year, a bad interruption to the Thursday Island cable was caused by the A.U.S.N. Company's steamer *Victoria* drifting down, fouling, and tearing it from its moorings on the Thursday Island beach. The harbour authorities at once took steps to, if possible, recover the end, but were unsuccessful, this cable being of a very heavy type, and beyond the power of any appliances that might have been on the island to recover and re-lay. Very fortunately, the Eastern Extension Cable Company's steamer *Sherard Osborne* was on her way through Torres Straits to New Zealand at the time, and the General Inspector N.D. (Mr. Bourne), who had been sent from Bowen at the first intimation of the disaster, succeeded in making arrangements for the vessel named to pick up, repair, and re-lay the cable. A new piece of 350 fathoms had to be inserted, so much damage had been done.

Recently the cable between Woody and Fraser's Islands showed symptoms of leakage, which quickly increased. The electrician (Mr. Starke) went up as soon as possible, and, discovering the fault, found it advisable to insert about 55 fathoms of new. This, with the interruption of two small cables near Brisbane completes the list.

At the present moment all the submarine wires are working perfectly.

Since last report the new Telephone Central Exchange has been completed, the multiplex board fitted, and the wires removed from the old exchange. More of the Felton-Guilleaume cable has been brought into circuit, and is most satisfactory in its working. The various country exchanges are working well, and although in some places the number of subscribers has decreased there is every reason to expect, with a revival of business, an increased number of applications for connection with the exchanges.

THE ELECTRICAL RESISTANCE OF METALS.

By M. H. LE CHATELIER.

I HAVE shown, in a previous communication (*Comptes Rendus*), how the determination of electrical resistances can be turned to account for the study, at high temperatures, of the molecular transformations of metals. I propose to-day to extend the applications of this method to a new series of metals and alloys.

The metals that show no molecular transformation before fusion, possess electrical resistances, the variation of which is a linear function of the temperature. Here are some examples :

Resistance in ohms of wires 1 millimetre in diameter.

Pt	...	...	0.140	+	0.000325 t
Pt + 10 per cent. Rh.	...	...	0.335	+	0.000350 t
Cu	...	...	0.032	+	0.000101 t
Cu + 10 per cent. Sn.	...	...	0.150	+	0.000109 t
Cu + 20 per cent. Ni.	...	...	0.420	+	0.000110 t
Ag	...	...	0.023	+	0.000105 t

It will be observed that copper, silver and their alloys have an incremental coefficient that is to all intents identical, amounting to about 0.000105 ; that of platinum and its alloys is three times as great. Generally speaking, the introduction of small quantities of foreign substances into a metal raises its resistance curve, causing it to take a direction parallel to its original position. Silver showed an interesting peculiarity. On being heated in oxygen, its resistance curve remained perfectly rectilinear, its mechanical properties were not modified, and its melting point was found to be 945°, given by M. Violle. When, on the other hand, it was heated in hydrogen, all its properties were modified after 650° ; the electrical resistance increased more rapidly than in oxygen ; the metal, after cooling, was extremely fragile ; wires .25 of a millimetre in diameter could be bent without being broken. And, lastly, the melting point fell to 915°. The metal assumes a dull appearance similar to that occasioned in palladium by the decomposition of its hydruet (hydrure). These facts show that silver absorbs hydrogen at red heat. I found that the quantity of hydrogen absorbed is insufficient to form a definite combination and that, after cooling, the metal does not retain it in any appreciable quantity.

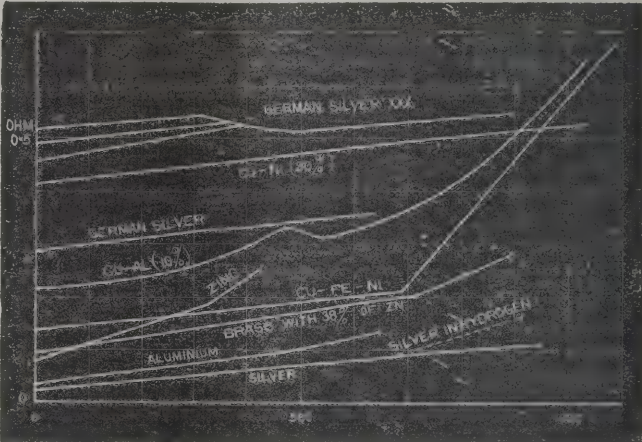
Many metals show, like iron, sudden molecular changes, produced at certain fixed temperatures. At these temperatures the electrical resistances undergo no change on passing one of these points of transformation as it does at the melting points. The accompanying curves give different examples of these phenomena. They were most clearly shown with an alloy consisting of Cu = 70, Ni = 18, Fe = 11. The temperatures at which molecular transformations occurred were found to be for the three following metals :

Zn.	Brass containing 38 per cent of Zn.	Alloy—Cu—Fe—Ni
360°	720°	690°

I ascertained directly in the case of brass that the transformation is accompanied by a considerable absorption of latent heat.

Some alloys show progressive molecular transformations, reminding one of those observed in the chemical equilibrium of saline solutions, in solutions of salts of chromium, of chloride of copper, &c. The transformation is not sudden, but is more often effected within certain limits of temperature. This is the case with slightly silicious aluminium bronze, the transformation of which takes place between 550° and 650°. It is

above this last temperature that the tempering of the metal is effected. But this peculiarity is shown in a marked degree in German silver and in alloys of copper and nickel. When these alloys are heated, their resistance decreases rapidly between 300° and 500°. In order to observe this phenomenon, it is indispensable that we should obtain metal that has been annealed (recuit) and cooled very slowly. In the case of German silver, we can only avoid its being almost completely tempered, by making the fall of temperature from 500° to 300° occupy several hours. The transformation seems also to be impeded by the presence of small quantities of foreign matter ; in any case the extent of the transformation varies considerably in different samples of metal, and may even be altogether absent, as in the case of the sample of copper alloyed with 20 per cent. of nickel (Cu-Ni 20 to 100), the resistance of which was given at the beginning of this note.



The following figures relate to three samples chosen from among a dozen that were tested :—

	0.	200.	300.	400.	500.	700.	900.
Cu 50 ...	0.465	0.480	0.505	0.520	0.518	0.530	0.552
Ni 24 ...	0.495	0.513	0.527	0.525	0.518	0.530	0.552
Zn 25 ...	0.514	0.527	0.537	0.525	0.518	0.530	0.552
Cu 66 ...	0.285	0.308	0.320	0.330	0.338	0.352	0.390
Ni 11 ...	0.485	0.497	0.500	0.492	0.475	0.473	0.492
Zn 22 ...							
Cu 81 ...							
Ni 18 ...							

The first of these alloys showed the most marked transformation. The three series of measurements were taken from the heating of specimens cooled at different degrees of rapidity, and consequently unequally tempered.

These experiments give the reason of the fact, already observed, that standard resistances of German silver change in course of time ; the magnitude of their resistance increases. This is because the wires employed are always partially tempered, and become annealed spontaneously under the influence of slight variations of temperature, of mechanical action, or even of the weather merely. We observe with wires of tempered steel a similar spontaneous annealing action, which is shown by a variation of resistance of a contrary sign.

In conclusion, I will give a table of the results obtained with alloys of iron and nickel. Certain of these alloys show, on being heated and cooled, different

Percentage of nickel.	Temperature.	0	200	400	600	800	1000	Points of transformation.
5	{ Rising	0.36	0.45	0.59	0.90	1.38	1.50	680° and 830°
	{ Falling	0.36	0.54	0.77	1.35	1.45	1.50	600°
25	{ Rising	0.98	1.15	1.30	1.42	1.51	1.55	none
	{ Falling	0.98	0.81	1.10	1.42	1.51	1.55	550°
35	Rising and falling	0.59	0.84	1.04	1.10	1.13	1.18	400°
50	Rising and falling	0.46	0.80	1.14	1.28	1.32	1.36	460°

resistances, *i.e.*, the transformations produced by the elevation of temperature are not immediately reversible; they do not take place when the temperature falls again until it is nearly same as the surrounding atmosphere.

It will be observed that iron, nickel and their alloys show at temperatures above the transformation point, a law of variation of electrical resistance which is analogous to that of platinum and its alloys. At lower temperatures, on the contrary, the rate of variation is infinitely more rapid.

### THE ELECTRIC LIGHTING, &c., OF BRUSSELS.

THE following report on electricity has just been issued by the authorities of Brussels:—The question of the electric lighting of the city has not yet received a solution. The offers made after the publication of the particulars last year by the council, gave rise to a serious discussion of the subject by the electricity committee. It was recognised that it was not advantageous to give attention to one or other of these offers any more than to those which had been made previously. It was consequently resolved to again ask for tenders, by indicating, in a detailed specification, the conditions it was thought advisable to impose on the concessionaries. If the offers are not regarded as more favourable than the former, the committee will propose the establishment of the electric light by the administration. The new propositions, which were to be sent in by August 1st last, are now under examination. The small electricity station used for the lighting of the Theatre de la Monnaie, the Hôtel de Ville, and the Grand Place, continued to work with the city's staff.

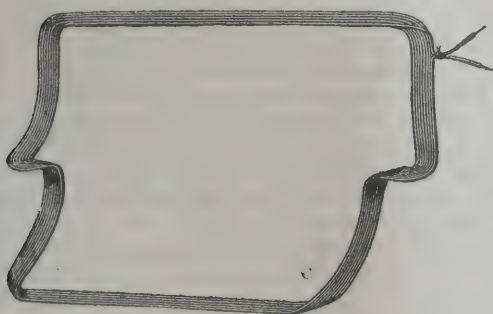


FIG. 1.

The lighting of the theatre had been uninterrupted. Numerous incidents, however, had arisen in the service of charging the accumulators. They had been obliged to raise the conductor cables placed in hooks in the collecting sewers, and fix them on insulators against the vault; and also, after several repairs of the armatures of the dynamos, the fear of an interruption of the lighting caused the ordering of a new armature. The masonry of the boiler has been replaced and braced. The 20-kilo. accumulators have done good service, and are still in good condition. Inside the theatre alterations have been made to facilitate the playing of an organ, which gave rise to some complaints during the season. The arc lamps, used to project the light on the stage, are now fed by accumulators. For the convenience of the staff, a telephone has been constructed between the theatre and the King's house. The electrical distribution in the Hôtel de Ville has been extended to the sheriff's rooms and to the archives office. An accident which happened recently to one of the provisional masts on the Grand Place, determined the authorities to order the execution of definite supports for the electric lamps which light the place. The communal telegraph service has been improved by the adoption of automatic apparatus in connection with the receivers, and by the establishment of a second apparatus in four divisions of police. In order to improve the service, notably as regards clocks, it was necessary to avoid con-

tact with the telephone wires by placing the wires underground; but the expense would be too great. As to lightning conductors, which continued to increase, the report gives as a proof of their utility, that during the violent storm of May 18th last, the lightning had struck several points of the outskirts, but nowhere in Brussels itself. The lightning conductors on the telegraph and telephone lines, however, showed numerous traces of the passage of the electric fluid.

### EICKEMEYER WINDING FOR ELECTRIC RAILWAY MOTOR ARMATURES.

A NEW departure, says the New York *Electrical Engineer*, has recently been made by the Edison General Electric Company in its electric railway work by the introduction upon its motors of the Eickemeyer method of armature winding, whose use it controls in that class of work. As our readers are aware, the armatures of electric railway motors have generally been wound upon the Siemens system, the main objection to which is that the irregular mass of wire at the end has a tendency to move, abrading the insulation and leading to a short circuit. As the burn out most frequently occurs in the under or inner coils, repairs are unduly expensive.

In the Eickemeyer system of winding, each armature coil, fig. 1, is wound upon a form of peculiar construction, and comes out standard and interchangeable in every respect. In building an armature originally, the laminated iron core is first prepared as in the Siemens armature, and upon this are loosely placed the necessary number of standard coils, which are locked

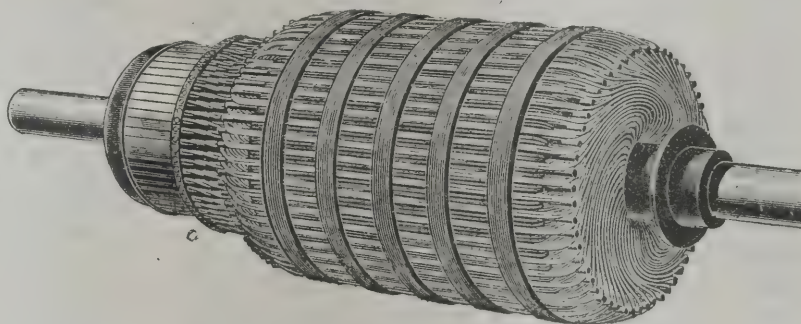


FIG. 2.

in place around the armature by means of the wooden pegs, shown in fig. 2. The result is, a square end both front and rear, instead of the cone-shaped end of the Siemens armature. The coils are held firmly in place, with absolutely no chance for motion, and there is no mechanical pressure from coil to coil which would tend to cause short circuit. The armatures are necessarily of standard diameter and interchangeable, and it is claimed that the Eickemeyer armature will never burn out except from dead over load causing melting of the wire, from accidental mechanical injuries, or from short circuit due to outside causes. If, however, an armature coil should burn out from any of the causes mentioned, it could be replaced without difficulty by any ordinary mechanic and without return to the factory, the whole operation consuming about a day's time and a small amount of material. The local railway company would be provided with a sufficient number of standard coils held in reserve.

Fig. 2 shows the peculiar curvature of the coils at the rear. The same curvature is found at the front end. The whole armature is perfectly ventilated, particularly at the front, where difficulty has frequently occurred. It is the strong belief of the Edison Company that one of the most serious difficulties that has been met with in electric railway work is entirely overcome by this new type of armature they are now manufacturing and using.

## THE PRESENT POSITION OF POSTAL TELEGRAPH CLERKS.

DEVOUTLY as the telegraph clerks may desire to put a period to the admittedly necessary remedial campaign which they have carried on for so many years, and satisfactory as the prospect of an equitable settlement of their claims would be to themselves and the public generally, yet it must be evident to all who have followed the subject recently that there is little or no prospect of an immediate closing of the gates of the telegraphic Temple of Janus. The hindrances to this desired end are not difficult to localise, involved as they are in the Postmaster-General's new scheme, and while for a time the rank and file of many of the postal telegraph clerks' battalions may be resting in the enjoyment of such successes as have already been gained, the results of Saturday's conference in Liverpool indicate that victory has not been gained at all points of the field, that it is not general "along the line," and that much has still to be done before the reasonable, and even modest programme, put forward as the sum total of a telegraph clerk's professional claims, receives official recognition.

There may ensue a brief season of comparative rest, when what we will call the "minor tactics" of the forces will probably be reorganised, when those already wearied with the excitement and anxiety of the strife, its many changes and its varied incidents, will recruit their nervous forces and gain rest for the mind.

No one who has not taken part in commercial or social reforms and movements of a similar nature can adequately realise what wear and tear they demand from the mental and vital forces of the human system. In the case of civil servants, an additional strain is enforced on the individual acting, for instance, on an executive committee. He has to display unwearied devotion to his official duty, being careful not to compromise his conduct officially, and at the same time prove not only to his colleagues but also to those in authority over him that his sincerity and his courage are equal to his professional zeal. We have known a rash or hasty step beyond a certain and often an unknown point to result in disaster to the cause, and reduction or dismissal to the individual.

Many of our readers will have read in the wonderful Italian campaigns of Napoleon of the way in which he ordered brigades and battalions, even in the heat of battle, to take what may appositely be called "hurried rests."

How beneficial these rests were the extent and importance of the little Corsican's many victories sufficiently attest. A brief period of tranquility will act, therefore, as a healthy stimulus to further action, and when the telegraph clerks resume their movement they will be more than ever hopeful of gaining those further concessions which they urge will effect a general settlement of their case.

Having referred to the position of the agitation in a military spirit, it does not follow that we are anxious to see further operations carried out in a bellicose fashion; our counsel has ever been in favour of rational and reasonable methods, and few will deny that the telegraph clerks have been uniformly orderly and businesslike.

Upon the whole, the Postmaster-General has approximated his subject fairly well. In clearing off arrears of long standing in such matters as overtime, bank holidays, and an instalment of justice with regard to sick-pay, he well merits the vote of thanks passed most loyally by the Liverpool Conference.

In the matter of increase of salary, he has not been quite so successful. He has stopped short where he was earnestly asked to effect his greatest reform; we refer now to the retention of the old system of classification. Whether this is the outcome of that official advice which he has considered so necessary, and which he has so highly praised, or the indication of doubt and hesitation on his own part is not very certain; on mature consideration we are inclined to think that it is due to the former cause,

The service cries aloud for a progressive system, such as exists in the Savings Bank, the Intelligence Department, the Receiver and Accountant-General's office, and in other departments. The old anomalies will, unless determined agitation be maintained, once more appear; in fact they are still existent.

In judging matters from the classification platform, we ask why such a glaring injustice should be perpetrated as the increasing of the maximum pay of every class in the service *excepting that of the Senior Class of Telegraph Clerks at the Central Telegraph Department*, which has been either studiously and purposely overlooked, or has been treated with entire indifference. As a representative class from which administrative officers are elected, it stands in a worse position now than it did twelve months ago. It must not be forgotten that the grievances complained of are common to all sections of telegraph clerks.

The clerks in this senior class do the duties of superior officials when occasion requires, but no consideration of any kind has been given to them, though they have as good a claim as any other class in the service. The Postmaster-General has admitted in the House of Commons that senior clerks have to perform the duties of assistant superintendents which involves control of staff, arrangement duties, technical and practical knowledge of telegraphy, adjustment of instruments and circuits, &c. Yet the new scheme contains absolutely nothing for them.

Can it be wondered, then, that there is dissatisfaction with classification. Another point, and one almost as glaring, though of a slightly different nature is, that telegraph clerks in receipt of £160 will no longer receive a month's leave annually, though until the introduction of the Postmaster-General's scheme every one in receipt of £150 per annum, or in a class going to that figure, was entitled to a calendar month's leave each year, and this is notified to the Post Office *employés* in what is known as the "Official Circular." Then, again, the method of awarding sick-pay is very unsatisfactory to the staff in general.

We have shown conclusively that the obstacles in the way of a complete settlement of the telegraph clerks case are those which have been either retained or raised by the Postmaster-General, and probably his advisers.

This is all the more to be regretted, as the Postmaster-General is quite within easy range of bringing affairs to a satisfactory conclusion. In addition to this, he gave to the deputations which waited on him early in the year such an impression of high-minded courtesy, consideration, and even personal sympathy, that such flaws and discrepancies in the new scheme, of which the Postmaster-General has publicly claimed a large constructive share, seem altogether at variance with the close and careful attention he devoted to these subjects when originally presented to him.

It would not be right in this case to blame the Treasury officials for any shortcomings in connection with the scheme, for not so very long since, with a dejected air of injured innocence, one of the Treasury officials in the House of Commons avowed meekly that it was not right to blame the Treasury Lords for being parsimonious or inconsiderate; indeed, such was not the case, and especially with regard to the Post Office, they had, indeed, granted every requisition that had been made on them by the Postmaster-General, they having only in view the commercial prosperity of the department and the best interests of the community. This lets a good deal of side light in on the conjuring done in the name of the Treasury, and may confirm the opinion held by well informed people that the Treasury is made the scapegoat of our modern constitutional government.

The speeches delivered at the Liverpool Telegraph Conference were carefully taken down by the "official reporter," who was present under protest, his intrusion being regarded as illegal; the Postmaster-General will therefore, in due course, find out for himself how near he has been to the point at which a general and satisfactory settlement would have been reached, and which many will regret is still left to the future.

## THE TELPHER AND ELECTRIC RAILWAYS OF THE EDINBURGH EXHIBITION.\*

By E. MANVILLE, M.I.E.E., and J. G. STATTER, A.M.I.C.E.

It may be said truly of the United Kingdom that its inhabitants are, as a whole, very slow in taking advantage of new applications of the forces of nature; and in no instance, perhaps, is this more so than in the application of electricity to traction. When at last, however, they have taken up a new application, they develop it more thoroughly than other nations.

In a paper on "Electric Traction," read by Mr. Bennett before the East of Scotland Engineering Association last year, he observed that whilst there were but few lines of electric tramway in operation in the United Kingdom, not one of these existed in Scotland. The same condition of affairs pertained at the commencement of this year when, through the enterprise of the council of this exhibition, Scotchmen are enabled to see two examples of the application of electricity to traction at work in their capital.

One of these—the telpherage system—is mainly the invention of the late Prof. Fleming Jenkin, who developed his ideas in the University of Edinburgh, and therefore this—the first telpher line erected in Scotland—should be especially interesting to you; the other—an electric tramway, worked from overhead conductors—is the first tramway completely worked by this method in the United Kingdom, and this paper is particularly descriptive of these two systems.

### TELPHERAGE.

Telpherage is a distinct and special application of electricity to traction particularly suitable for the carriage of goods over rough country where the cost of railways is too great. We do not suppose that it is likely to compete with heavy railways, but it is especially applicable to replace heavy cartage where the cost of transport frequently reaches 1s. per ton mile, which is many times the cost of carrying the same quantity on a telpher line.

Light railways have up to the present time been generally erected to supersede the primitive method of carting when the quantities to be carried reach from 100 to 500 tons per diem. The cost of a light railway where bridges, embankments, and cuttings have to be made is considerable, and far in excess of the cost of a telpher line over the same country. A telpher line spans rivers, crosses roads, bridges, valleys, and generally accommodates itself to the smoothing out of excessive gradients caused by the rough surface of the country, and even when the whole line is erected over a country continually rising from end to end of the line, the telpher locomotive can with facility be made to haul loads up gradients that are quite impracticable on an ordinary railway.

Ingenuous devices were invented by the late Prof. F. Jenkin, and brought into practical use, to enable the train to travel automatically without any driver to control it, and a telpher train so equipped goes along the level and ascends gradients and descends gradients at approximately the same speeds, and with a delicacy of regulation that it would be hard to attain in driving a train by hand.

It is the essential idea of telpherage that, instead of carrying heavy unit loads as in a railway and running but few trains a day to do the work, the unit loads carried should be small and the trains should follow each other frequently. As the trains move across miles of country unattended by a driver, and as the speed of any one train might be greater than that of the one in front, it is necessary to have a system of blocking that shall be absolutely certain, and here electricity lends itself splendidly to the object to be achieved.

With a steam locomotive, the most that can be done to stop it is to shut off the steam from the cylinders, but in an electric locomotive it is possible, so to speak, to remove the fire from the fire-box and the steam from the boiler, leaving the locomotive perfectly inert, and in arranging a block system on a telpher line the train in front is arranged to completely cut off the current from the section behind it, so that if the next train should run into this section it immediately loses all power of proceeding until the train in front has moved into a section further on; and thus all possibility of accidents by collision are completely removed.

The telpher line in the grounds of the exhibition measures about 430 yards all round. It is thus necessarily short owing to the space placed at the disposal of the Electrical Engineering Corporation, and does not meet in this short length with all the conditions that exist on lines of greater length and passing over various obstacles, and we therefore propose to describe to you a line recently constructed in Cornwall, which measures nearly three miles all round, and which, passing over country of a difficult nature, involves almost all the conditions that could possibly be met with in telpherage, and the construction of which along its main length is identical with that in the exhibition.

Its use is to convey tin ore from the mine of the Eastpool Tin Company to its stamps. As with the line in the exhibition, it starts with a loop of rigid rail supported in spans of 15 feet, each end of the loop being connected with the up and down flexible lines.

The height of the posts in the mine yard is such that the skeps or buckets which carry the ore only just clear the ground, and are, therefore, in a convenient position for the ore to be shovelled straight into them from the dressing floor. The train, when loaded, proceeds round the loop, passing over buildings in the mine yard and over the boundary walls into the open country, where the line becomes flexible. The posts are here of such a height that the bottoms of the skeps are about 15 feet from the ground, and the whole line ascends a gradient of 1 in 80. Some little distance from the mine yard a curve is reached, and the train leaves the cable to round the curve upon a rigid rail. Shortly afterwards the line crosses a road and then bridges a valley, where the posts rise to a height of nearly 70 feet, maintaining the same gradient and passing directly over the buildings of an ore dressing works and over the end of a row of two-storeyed houses.

After crossing the valley the height of the posts decreases again to about the same height as before, and the second curve is rounded, two more roads being crossed. The line now commences to descend a gradient of 1 in 33 until it reaches a spot rather more than half-way down. Here occurs an abrupt curve, almost a right angle, necessitating the train again leaving the flexible cable and rounding the curve upon a rigid rail. Advantage is taken of this sharp curve to divide the cables and hang requisite ropes upon their ends so as to maintain a constant tension.

Immediately after leaving the compensators the line crosses the high road from London to Penzance, and commences to descend a long gradient of 1 in 26.6. This gradient only ends when the Tolvaddon stamps are reached, where the flexible line terminates, and the train again travels on a rigid rail forming the loop joining the up and down lines at this end. On this loop the train passes the two engine-houses which drives the batteries of stamps, and the skeps are arranged to automatically tip their contents, without stopping, into the receiving hoppers of the stamps.

The engine-houses are fitted with the old type of Cornish engine, in which the beam projects from the engine-house and turns a long crankshaft through a connecting rod about 21 feet in length, and the telpher train passes right over the bob of the engine in the first house at a height of 40 feet from the ground and wends its way beneath the bob of the second engine between the connecting rod and the pump rod. Immediately after the second engine-house the return flexible cable is reached, and the train now travels back empty up the gradient of 1 in 26.6 to the mine yard, where it is reloaded.

The posts supporting the line are constructed in the same manner as those in the exhibition grounds, and consist of two stout baulks of timber, 9 inches by 9 inches, securely bolted and doweled together and bedded to a considerable depth in the ground, and to these are attached the arms which support the cables. These arms consist of a wrought iron strap with a cast iron strut, one on each side of the post, and where the line is flexible are arranged to swing. This is rendered necessary by the movement in the rope caused by the compensation weights referred to later on; and the saddles to which the cables are directly attached are placed at the extremities of these arms and arranged to rock up and down to enable the train to easily pass over them, and also to swivel in a lateral direction to remain parallel with the rope, notwithstanding the movement caused in the arms by the compensation weights.

As it is necessary not to impede the movement of the ropes produced by the compensation weights when passing round a curve, an arrangement is made for the cables to pass through a junction saddle, so shaped as to allow the train to easily pass from the cable to the rigid rail, the cables then rounding the curve and being kept clear of the rail and other obstructions by the horizontal pulleys shown, passing again away from the rigid rail by means of similar junction saddles. These junction saddles are so designed that the cable is free to move through them, at the same time being firmly supported when the train passes from the cable to the rail.

An arrangement of compensation weights and junction saddles enables the rope to move under the rail, and are much the same as those just referred to. But the cables are ended here and pass over pulleys of larger diameter, and have hung on their ends respectively a weight of about six tons on the side which carries the loaded train, and a weight of about four tons on the side which carries the light train.

The rolling stock for this line consists of three trains, each one carrying five tons of ore. Each consists of 20 skeps, each of a capacity of a quarter of a ton, and two locomotives of about 3 H.P. each. As will be obvious, the rope sags as the train passes in between the posts, and the amount of sag produced by the weight of the train with the compensation weights hung upon the end of the cable is about 4 feet per span on the loaded side, and 5 feet per span on the light side, the spans being about 100 feet. The locomotives are so spaced that one locomotive is always descending a sag whilst the other locomotive is ascending a sag. The same is true of the skeps, so that the train is to all intents and purposes balanced throughout its length, notwithstanding the inclines on the cables over which it passes.

The locomotives are almost exactly similar in construction to those used on the exhibition line. They consist of a framework above the line carrying the driving wheels. From this framework is suspended beneath the line a platform carrying the motor, and the motor is connected through a countershaft by a pitch chain with the driving wheels on the framework above, and the platform containing the motor and gear is so arranged as to swing from the framework above without altering the relative positions of the driving chains and wheels. This is a point of considerable im-

\* Paper read at the Edinburgh International Exhibition, before the Royal Scottish Society of Arts.

portance in enabling the locomotives to pass over the sharp incline at the post heads without either of its driving wheels losing grip of the rope.

The countershaft to which the motor is geared carries a special form of centrifugal governor devised by Prof. Fleeming Jenkin, and which automatically cuts off the current from the train when it is proceeding at too great a speed, re-establishing the circuit when the speed has fallen again to the normal.

On the end of the motor spindle is carried a centrifugal brake, which comes into action after the governor has cut off the current and the speed still increases. This is also a design of Prof. Fleeming Jenkin, and we believe we are correct in stating it is the first centrifugal automatic brake ever brought into practical use. It is perfectly reliable, and the loaded trains descend the gradient of 1 in 26.6 by its aid with perfect safety.

The driving wheels of the locomotive are arranged with renewable grooved tyres of a V-shape, which gives an adhesion to the locomotive of about 900 lbs. per ton.

The current is supplied to the line at a difference of potential of about 200 volts. As in the exhibition line, the cables form a return path for the current, a conductor supported on mica insulators carrying the current to the motors, and a small shoe resting on the conductor, and towed along by each locomotive, collects the current.

The duty of the line is about 250 tons per day of 10 to 11 hours working.

The facility with which the curves are rounded will, we believe, commend itself to engineers, and is a distinct advance over a hauling rope aerial railway, at every curve of which a man has to be stationed to push each skip round the rigid rail until it reaches the moving rope again.

This description has purposely been kept as non-technical as possible. That Scotland offers a wide field for the use of telerphage cannot be doubted, and we think we cannot do better than conclude this part of the paper by quoting from Mr. Bennett's paper referred to before, in which he says, "It is only necessary to cast a casual glance at the map of Scotland to perceive that one of its leading characteristics is the absence of railways. Vast tracts of fertile country in Haddington, Berwick, Selkirk, Roxburgh, Peebles, not to mention the more northern counties like Argyll and Inverness, are so many miles from the nearest railway that farmers and other producers are handicapped by the dearth of communication. They cannot compete in the market with rivals more favourably situated on one or other of the existing lines. It would certainly not pay to open up most of these districts, even if a single track and light engine were employed, but they might use telerphage lines laid over the public roads, or close beside them."

#### THE ELECTRIC RAILWAY.

It is not too much to state that the attention of the civilised countries of the world at the present moment is directed to the advance of electric traction as applied to tramways, due to the phenomenal development it has achieved in the United States.

But a few years since there were only a few lines of electric tramway in the States, and these altogether experimental lines. At the same period there were over 5,000 miles of horse tramway, and over 100 miles of cable tramway in operation in the United States. To-day there are about 2,000 miles of horse tramway in the States, over 200 miles of cable tramway, and no less than 2,000 odd miles of electric tramway.

In *Duncan's Tramway Manual* for 1890 will be found a statement that the total mileage of the lines opened to traffic in the United Kingdom at the end of 1889 was 940 miles; therefore, the mileage of electrical tramways in the States exceeds the total mileage of all the tramways in the United Kingdom by more than 100 per cent.

To us in this country it is difficult to conceive how three or four companies could have turned out of their factories and set to work such an enormous amount of electrical plant as this represents in so short a time. Evidently, instead of using their time in persuading tramway companies to have their lines worked by electricity, they have devoted all their time to executing orders which must literally have been poured in upon them by the tramway companies.

The large mileage thus being worked in America enables us to form a judgment beyond question as to the cost of operating electrical tramways from fixed conductors, either overhead or underground, and we may take the figure of 3d. per car mile as the total amount for traction; and in the cases of large systems it is certain that this figure would be even less.

Now, the total amount of capital invested in tramways in the United Kingdom is about £14,000,000 sterling, and the average cost of horse traction is certainly above 5d. per car mile. It is, therefore, obvious that an average saving of at least 2d. per car mile would be achieved were the tramway systems in the United Kingdom worked electrically. The total number of car miles run during the year ending June 30th, 1889, in the United Kingdom was 62,000,000, and the saving of 2d. per car mile in the working expenses would represent a sum of over £500,000, which would be a substantial addition to the dividends now paid on the capital invested in tramways.

Surely figures of this kind must appeal to those shareholders who have subscribed this large amount of capital, and who would, immediately their tramways were worked electrically, earn this extra dividend; and if tramway directors are slow of themselves in adopting this successful and economical method of propelling their

tramcars, it should be the duty of the shareholders in their own interests to stimulate them to its adoption.

There are, roughly, three methods in which electric tramways may be operated electrically: 1. With conductors supported overhead on poles or wires, as with the line in the exhibition. 2. Conductors laid under the road surface in a conduit. 3. Without conductors at all, the energy being derived from accumulators carried within the car itself.

The first two systems derive their energy at all points of the line from a generating station containing the boilers, engines, and dynamos, or, if there should be water power in the neighbourhood of the tramway, from turbines and dynamos, and these must be kept constantly running as long as the tramcars are in motion. In the third method there is a generating station as before, but the current generated therein, instead of being conveyed direct to the cars by conductors radiating from the station, it is utilised for the charging of batteries of accumulators which are carried by the cars; and the cars, therefore, are not dependent for their motion upon the continuous running of the machinery in the generating station. This, coupled with the fact that the cars can run on any line without alteration to the track—assuming it is strong enough to bear the weight—constitutes the advantage of this system, which, however, cannot at all compare in cost of maintenance with the direct conductor method, and, therefore, will not be dealt with in this paper.

The first method with conductors suspended overhead is the method adopted by an overwhelming large percentage of the electrical tramways in existence. A bare conductor of silicium bronze is suspended overhead, either directly from a bracket attached to a post, if the track runs by the side of the road, or from a cross suspension wire stretched between two posts on either side of the road if the track runs in the centre of the road. This conductor of silicium bronze is insulated from the bracket or from the cross suspension wire, by means of an insulator composed almost entirely of mica, and much stronger and better adapted for the work than an ordinary porcelain insulator.

The size of this bare conductor, or trolley wire, as it is more usually termed, may be any size from No. 6 to No. 2 S.W.G.; and if the length of the tramway and the number of cars running upon it is such that the conductivity of the larger size wire would be too small, another insulated cable is run along the posts supporting the brackets or suspension wires, and tapped at intervals into the bare conductor or trolley wire to reduce its total resistance.

Where turn-outs or crossings occur, points and crossings—of much the same description as those used on the tramway lines underneath—are provided, but, of course, are inverted.

The current is collected from the trolley wire by means of a long, light, and strong swivelling arm mounted on the car roof, at the end of which is either a small wheel or a sliding shoe. The wheel or shoe is kept pressed against the bare conductor overhead by a spring or weight at the other end of the swivelling arm, and this method of maintaining contact with the overhead conductor leaves nothing to be desired in practice. It matters hardly at all how rough the track may be, the collecting shoe remains pressed against the conductor with a pertinacity that is quite phenomenal, and it hardly ever leaves the trolley wire.

The silicium bronze trolley wire being of a very hard nature, and the rubbing surface of the contact shoe or contact wheel being soft, the trolley wire itself hardly wears at all, all the wear being on the sliding shoe or wheel, and these are provided with renewable tyres, which cost but little, and, indeed, the total cost of the wear and tear between an overhead conductor and the sliding shoe or wheel is so little that it is hardly calculable per car mile run.

The City of Boston is supposed to be one of the finest architecturally in the United States, and at the present moment the whole of the tramways of the City of Boston—one of the largest tramway systems in any one town of the world—is being fitted up with overhead conductors. Surely, if there is no objection in a large city like this to the use of overhead conductors under these conditions, in this country there must be numerous opportunities, at least in smaller towns and country lines, for utilising the same simple and efficient method of conducting the current to electric tramcars.

No doubt it requires but the introduction of a few such lines substantially erected to overcome the prejudice of local authorities to the use of overhead conductors.

In the larger towns, however, there is no likelihood of the authorities ever permitting the use of overhead conductors, and then the choice is limited to the use of either the accumulator system or the second method mentioned—viz., conductors laid under the road surface. We do not believe that with the present large depreciation upon accumulator cells this method will find favour with most tramway conductors, and that, therefore, the underground system is destined to be that ultimately used in our larger cities.

Of late there have been advocated several systems in which a closed conduit is used containing a conductor insulated from the earth and brought temporarily into contact with a surface rail divided into sections, as the car passes over these sections. This plan has not, however, been yet brought into operation on any practical scale, and we believe that although such a system might be made to work on a small scale under favourable conditions, it is improbable that with the very unfavourable electrical conditions of an ordinary road, this system could be relied upon for constant satisfactory working.

In the other or open conduit system two methods of constructing the conduit itself, as apart from the electrical fittings it contains, may be used. The first consists of building a conduit

between the two track rails and having upon the surface of the road a slot formed by two rails laid flush with the pavement, and introducing an extra amount of metal in the road, which is more or less objectionable to the local authorities. In March of last year, however, an electrical tramway at Northfleet was opened, in which for the first time the conduit was built underneath one of the running rails, the car wheels on one side travelling on one of the rails forming the slot of the conduit itself. This method of construction meets the objections of the local authorities, as it does not in any way add to the amount of metal placed upon the road surface.

Of open conduit systems with continuous conductors several have been tried without success. The objection to those tried so far, however, has been that the conductor is buried in the conduit, and cannot be got at without ripping open the conduit itself, and, as the size of the conduit must necessarily be small to keep the cost of construction to as low a figure as possible, very imperfect insulators are provided for supporting the conductors within the conduit, and these cannot be got at with facility for cleaning purposes. As a result the insulation is very imperfect and considerable leakage of current usually follows, and any repairs to the conductor necessitates a stoppage of the tramway and a taking up of the road.

To ensure an absolutely reliable open conduit system it is essential (1) that all the electrical fittings should be so designed that they can be placed in position or removed for the purposes of renewal without disturbing the road surface, and they must at all times be easy of access; (2) to ensure good insulation the supports should be as infrequent as possible, and where requisite they should be insulated from the rail by means of efficient insulators; (3) rigid collecting arms should be employed to ensure absolute accuracy of travel, to prevent any risk of contact being broken, and to dispense with points and crossings on the conductor; (4) all the devices used, either electrical or mechanical, must be very simple and cheap.

What is now known as the Waller-Manville system of conduits has been designed with a view to embody all these important considerations. In this system is employed a flexible conductor sufficiently small to admit of its being placed in or withdrawn through the slot. The conductor being flexible, the supports can be at long intervals, such as 30 feet, and can therefore be placed in side openings to the conduit and not in the conduit itself. By this means space is provided for large and efficient insulators. Removable covers are provided to these side openings, or hatchways, giving ready access to the insulators. The insulators are mounted in such a manner that, on removing the cover, they can be at once lifted out.

The collecting arm is so designed that the shank can be withdrawn through the slot, and the collector proper through any hatchway.

Under ordinary conditions the conductor simply rests on supporting arms without being attached thereto. When it is necessary to firmly attach the conductor to its support, as, for instance, on sharp curves, absolute flexibility is still maintained, as the supports are so designed that, whilst rigidly resisting either a longitudinal or lateral strain, the same freedom of upward movement is allowed, as in the case of the conductor itself when unattached.

Simple automatic apparatus is provided at intervals to maintain a constant strain upon the conductor, and to prevent sagging too much between the supports.

The current is collected by means of a U-shaped collector, or shoe, in which the conductor runs, the collector lifting the conductor off the ordinary supports during its travel, and in the case of the supports to which the conductor is attached lifting the support itself.

The conductor rests upon the collecting shoe, which passes clear of the supporting arm of the insulator, allowing the conductor when it has passed to fall back again upon the supporting insulator. This method of collection is similar to that which has been described as having proved extremely efficient with the overhead system.

An automatic tension apparatus is so designed that whilst maintaining a constant tension upon the conductor no extra strain or weight is put upon the collecting arm as it passes beneath the apparatus.

It will be seen, then, that whilst all the conditions which are met with in a tramway are fulfilled, the apparatus employed to fulfil these conditions never interferes with the upward flexible movement of the conductor upon which the perfect contact thus obtained depends; also, that no nuts or bolts, or other means of permanently attaching the insulators and their supports to the conduit, are used. Each insulator with its support is complete in itself, and can be removed from the hatchway instantly for cleaning purposes or renewal. The conductor requires the minimum of work to place it in position, as it is but necessary to drop it through the slot along the road to fasten it to the compensating devices and curve devices, and then the mere action of the collecting shoe passing under the conductor the first time places it in position on the supports along the straight parts of the line.

One of the difficulties hitherto encountered with conduit tramways is that of keeping the conduit itself clear of dirt and road debris owing to the obstruction caused by the electrical fittings to the passage of a brush or cleaning device. It will readily be seen that this difficulty does not exist in this system, there being no obstruction to the passage of a brush attached to a car which will sweep the dirt into receptacles provided at the hatch-boxes, from whence it can readily be removed.

Before concluding this paper, we would describe to you the method used on the exhibition tram line for attaching the motors to the tramcars and gearing their armatures up to the car wheels. The same method is used whether the current be supplied from overhead conductors or from underground conductors on a very large percentage of the electrical tram lines now in operation, and experience has proved it to be a very satisfactory method indeed.

The field magnets of the motor are supported in a cradle of gun-metal, which also supports the bearings for the armature and for the countershaft. One end of this cradle terminates in an eye running over a stud supported on a beam carried across the bottom of the car truck, and a flange round the eye rests upon a strong spring; the other end of the cradle terminates in two plumper blocks, which rest directly upon one of the axles of the truck.

The armature is geared to the countershaft by a cast-steel double helical pinion and wheel, and the other end of the countershaft is geared to the car axle by a similar pinion and wheel.

By thus only attaching the motor at one end of the car axle, and allowing it to move to a certain degree radially round the car axle, by supporting at the other end in the way described, great flexibility is obtained, and the effect of the vibrations caused by the wheels travelling over the track and communicated to the motor are thus minimised as far as possible.

Those who are interested in this method of mounting the motor can inspect the arrangement on one of the cars in the grounds, and also any of the other details referred to in this paper.

We have endeavoured to describe to you, in perhaps an imperfect manner, besides the system of telferage, the methods of working electrical tramways through overhead conductors or underground conductors in an open conduit. The subject is one of pressing interest at the present time, and is worthy of treatment at far greater length than is possible within the limits of this paper; and this must be our excuse for making the descriptions as short as possible, and not entering into many details which in themselves are important.

## ELECTRIC LIGHTING REGULATIONS.

MR. COURTNEY BOYLE has forwarded the following copy of regulations issued by the Board of Trade to undertakers under the Electric Lighting Act:—

Regulations and Conditions for securing the safety of the public and for ensuring a proper and sufficient supply of Electrical Energy, made by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888, and of the Metropolitan Electric Supply Company (West London) Lighting Order, 1889.

### Definitions.

In the following regulations—

The expression "the order" means the Metropolitan Electric Supply Company (West London) Lighting Order, 1889.

The expression "the undertakers" means the undertakers for the purpose of the order.

The expression "consumer" means any body or person supplied or entitled to be supplied with energy by the undertakers.

The expression "consumer's terminals" means the ends of the electric lines situate upon any consumer's premises and belonging to him at which the supply of energy is delivered from the service lines.

The expression "consumer's wires" means any electric lines on a consumer's premises which are connected with the service lines of the undertakers at the consumer's terminals.

The expression "aerial conductor" means any conductor which is placed above ground and in the open air.

The expression "pressure" means the difference of electrical potential between any two conductors through which a supply of energy is given, or between any part of either conductor and the earth; pressure on any alternating current system being taken to be the equivalent of pressure on a continuous current system when it produces an equal heating effect if applied to the ends of a thin stretched wire or carbon filament; and—

(a.) Where the conditions of the supply are such that the pressure cannot at any time exceed 300 volts, if continuous, or the equivalent of 150 volts, if alternating, the supply shall be deemed a low pressure supply;

(b.) Where the conditions of the supply are such that the pressure may exceed the limits of a low pressure supply, but cannot exceed 3,000 volts, or the equivalent of 3,000 volts, whether continuous or alternating, the supply shall be deemed a high pressure supply;

(c.) Where the conditions of the supply are such that the pressure may on either system exceed 3,000 volts, or the equivalent of 3,000 volts, the supply shall be deemed an extra high pressure supply.

Mains, service lines, and other conductors and apparatus are referred to as low pressure, high pressure, and extra high pressure mains, &c., according to the conditions of the supply delivered through the same or particular portion thereof.

Provided that in the case of conductors laid under the surface of the ground in conduits, in accordance with these regulations, and being the property or under the sole charge of the undertakers, low pressure conductor shall mean any conductor in which

the pressure between that conductor and the earth cannot at any time if continuous exceed 300 volts, or, if alternating, 150 volts, or between that conductor and any other conductor laid in the same conduit cannot at any time if continuous exceed 500 volts, or, if alternating, 250 volts.

When any casing, support for conductors, conducting wire or other metallic body is required to be efficiently connected to earth, it shall be deemed to be so connected when it is connected to metallic mains for water supply outside of buildings, or, where these are not available, to a mass of metal having a total surface of at least four square feet, buried to a depth of at least three feet in moist earth, by means of a conductor possessing a mechanical strength, and offering a passage to electrical discharges equal to that of a strand of seven No. 16 galvanised iron wires.

The expression "daily penalty" means a penalty for each day on which any offence is continued after conviction thereof.

All other expressions to which meanings are assigned in the order or principal Act have the same respective meanings in these regulations.

#### I.—REGULATIONS AS TO SAFETY.

##### *General.*

(1.) Save as hereinafter provided, the supply of energy delivered to the consumer's terminals shall be a low pressure supply.

(2.) A high pressure supply shall not be delivered to any consumer's terminals, except for special purposes, and with the approval of the Board of Trade on the joint application of the consumer and the undertakers, and subject to such further regulations as the Board of Trade may from time to time prescribe. But a high pressure supply may be given to distributing or converting stations or points, or to distributing mains, in accordance with the following regulations.

(3.) An extra high pressure supply shall not be given except to distributing stations or other premises in the sole occupation of the undertakers, and with the written consent of the Board of Trade, and subject to such regulations and conditions as the board may prescribe.

##### *Mains and other Conductors.*

(4.) The maximum working current shall not be sufficient to raise the temperature of the conductors or any parts thereof to such an extent as to materially alter the physical condition or specific resistance of the insulating covering, if any, or in any case to raise such temperature to a greater extent than 30° of Fahrenheit's thermometer; and efficient automatic means shall be provided which will render it impossible for this maximum working current by any accident to exceed such limit to the extent of 50 per centum, even for short intervals of time; and special care shall be taken that the cross sectional area and conductivity at joints are sufficient so avoid local heating, and that the joints are protected against corrosion.

(5.) Where any portions of any conductors are exposed in such a position as to be liable to be affected by lightning, they shall be efficiently protected against accident by appliances of such pattern and construction as may from time to time be approved by the Board of Trade.

(6.) Where any high pressure conductors, other than aerial conductors, are placed above the surface of the ground, they shall be completely enclosed in brickwork, masonry, or cement concrete, or in strong metal casing efficiently connected to earth.

(7.) Where any high pressure conductors are laid in subways, or in the same conduits with any low pressure conductors, they shall be completely enclosed in strong metal casing efficiently connected to earth.

(8.) Where any high pressure conductor is laid within a less distance than 18 inches from any low pressure conductor or from the surface of the ground, or where any low pressure conductor is laid within the above-mentioned distance from any previously laid high pressure conductor, efficient means shall be taken to render it impossible that the low pressure conductor or the surface of the ground shall become electrically charged by any leakage from or defect in the high pressure conductor.

(9.) Every high pressure conductor shall be continuously insulated with a durable and efficient material which shall be protected on the outside against injury or removal by abrasion, and every such conductor shall be tested for insulation after having been laid in position and before any joints for service lines are made. The insulation resistance under these conditions shall not be less in any section of the conductor than at the rate 100,000 ohms per mile for every volt of pressure of the supply under a testing pressure of at least 100 volts, and the undertakers shall duly record the results of the tests of each conductor, or section of a conductor, and at all times permit an electric inspector to examine and take copies of such record.

(10.) The insulation resistance of any complete circuit used for high pressure supply, including all devices for producing, consuming, or measuring energy, connected to such circuit, shall be such that should any part of the circuit be put to earth through a resistance of 2,000 ohms, the leakage current shall not exceed 0.04 ampere in the case of continuous currents, or 0.02 ampere in the case of alternating currents. Every such circuit shall be fitted with an instrument of such pattern and construction as may from time to time be approved by the Board of Trade, which shall immediately indicate any defect which may at any time occur in the insulation resistance of either conductor.

Every such circuit shall be tested for insulation at least once in every week, and the undertakers shall duly record the results of

such testings, and at all times permit an electric inspector to examine and take copies of such record.

(11.) In the case of a high pressure supply on any alternating current system, where separately insulated conductors are laid in the same conduit or pass through the same boxes, precautions shall be taken against the discharge of electric sparks between the insulating covering of oppositely charged conductors, by providing a sufficient connection of a conducting nature from one covering to the other throughout.

##### *Conduits.*

(12.) All conduits used as receptacles for conductors shall be constructed of durable material, and of ample strength to resist any pressure due to heavy traffic or other forces to which they may be expected to be subjected.

(13.) Where the conductors in any conduit are not continuously insulated, adequate precautions shall be taken to ensure that no accumulation of water shall take place in any part sufficient to raise the level of the water into contact with the conductors.

(14.) All conduits for conductors constructed in streets in which gas mains are also laid, shall be efficiently protected against an accumulation of gas.

(15.) All street boxes shall be efficiently protected against an accumulation of gas or water, and their covers so secured that they cannot be opened except by means of a special appliance.

##### *Converting Stations.*

(16.) Converting stations, or points in a system of distribution to which a high pressure supply is given from generating stations, and from which a low pressure supply is given to one or more consumers, and which are not on the consumer's premises, shall be established in suitable places, which are in the sole occupation and charge of the undertakers.

(17.) In every case where the supply is transformed at a converting station as described in the preceding regulation, some means or apparatus approved by the Board of Trade shall be provided which shall render it impossible that the low pressure distributing mains shall be at any time charged to a dangerous difference of potential from the earth, owing to any accidental contact with, or leakage from, the high pressure system either within or without the converting station.

##### *Consumer's Premises.*

(18.) Where the general supply of energy is a high pressure supply, and transforming apparatus is installed on the consumer's premises, connected to the distributing mains by high pressure service lines, and to the consumer's terminals by low pressure service lines, the whole of the high pressure service lines, conductors, and apparatus, including the transforming apparatus itself, so far as they shall be on the consumer's premises, shall be completely enclosed in solid walls, or in strong metal casing efficiently connected to earth, and securely fastened throughout.

(19.) In every case where any transforming apparatus is installed on the consumer's premises, as described in the preceding regulation, some means or apparatus approved by the Board of Trade shall be provided, which shall render it impossible that the low pressure service lines and consumer's wires shall be at any time charged to a dangerous difference of potential from the earth, owing to any accidental contact with, or leakage from, the high pressure system either within or without the transformer.

(20.) All terminals, low pressure service lines, or other apparatus, between the transforming apparatus or other source of supply and the consumer's terminals, so far as they shall be on the consumer's premises, shall be completely enclosed in insulating cases or coated with insulating material in such a manner that no part of them can be touched by any person without the removal of such case or coating, and, wherever exposed, shall be efficiently protected against injury to the insulation.

(21.) The undertakers shall be responsible for all electric lines, fittings and apparatus belonging to them, or under their control, which may be upon the consumer's premises being maintained in a safe condition and in all respects fit for supplying energy.

(22.) In delivering the energy to the consumer's terminals the undertakers shall exercise all due precautions so as to avoid risk of causing fire on the premises.

(23.) If the undertakers are reasonably satisfied, after making all proper examination by testing or otherwise, that a connection with the earth exists at some part of a circuit of such resistance as to be a source of danger, and that such connection does not exist at any part of the circuit belonging to the undertakers, then and in any such case any officer of the undertakers, and duly authorised by them in writing, may, for the purpose of discovering whether such connection with the earth exists at any part of a circuit within or upon any consumer's premises, at all reasonable times, after giving one hour's notice of his intention to do so, enter any such premises and disconnect the consumer's wires from the service lines, and may require the consumer to permit him to inspect and test the wires and fittings belonging to the consumer and forming part of the circuit.

(24.) If on such testing the officer discovers that a connection exists between the consumer's wires and the earth, and that such connection has an electrical resistance not exceeding 5,000 ohms, or if the consumer does not give all due facilities for such inspection and testing, the undertakers shall forthwith discontinue the supply of energy to the premises in question, giving immediate notice of such discontinuance to the consumer, and shall not recommence such supply until they are reasonably satisfied that such connection with the earth has been removed.

Provided that in cases where the maximum power taken by any consumer exceeds 25,000 watts, the consumer's wires may be divided for the purposes of this testing into separate circuits, the insulation resistance of each of which shall exceed 5,000 ohms.

(25.) If any consumer is dissatisfied with the action of the undertakers either in discontinuing or in not recommencing the supply of energy to his premises, the wires and fittings of such consumer may on his application and payment of the prescribed fee be tested for the existence of connection with the earth by an electric inspector, or if no electric inspector has been appointed, by a person appointed by the Board of Trade.

This regulation shall be indorsed on every notice given under the provisions of the last preceding regulation.

*Regulations as to Aerial Conductors where erected with necessary consents.*

(26.) An aerial conductor shall not in any part thereof be at a less height from the ground than 20 feet, or where it crosses a street, 35 feet, or within 7 feet of any building or erection other than a support for the conductor; except where brought into a building for the purpose of supply.

(27.) Service lines from aerial conductors shall be led as directly as possible to insulators firmly attached to some portion of the consumer's premises which is not accessible to any person without the use of a ladder or other special appliance, and from this point of attachment to the consumer's terminals they shall be enclosed and protected in accordance with the preceding regulations as to service lines on the consumer's premises.

(28.) Every aerial conductor shall be attached to supports at intervals not exceeding 200 feet where the direction of the conductor is straight, or 150 feet where this direction is curved, or where the conductor makes a horizontal angle at the point of support.

(29.) Every support of aerial conductors shall be of a durable material, and properly stayed against forces due to wind pressure, change of direction of the conductors, or unequal lengths of span, and the conductors and suspending wires (if any) shall be securely attached to insulators fixed to the supports. The factor of safety for the conductors and suspending wires shall be at least six and for all other parts of the structure at least 12, taking the maximum possible wind pressure at 50 pounds per square foot. No addition need be made for a possible accumulation of snow.

(30.) Every support, if of metal, shall be efficiently connected to earth, and if of wood or other non-conducting material, shall be protected by a lightning conductor fastened to its support along its entire length, and projecting above the support to a height of at least six inches, such lightning conductor being efficiently connected to earth.

(31.) Where any aerial conductor crosses a street, the angle between such conductor and the direction of the street at the place of such crossing shall not be less than 60°, and the spans shall be as short as possible.

(32.) Where any aerial conductor belonging to the undertakers is erected so as to cross any other aerial conductor or any suspended wire used for purposes other than the supply of energy, precautions shall be taken by the undertakers against the possibility of their conductor coming into contact with such other conductor or wire, or of such other conductor or wire coming into contact with their conductor by breakage or otherwise.

(33.) Every high pressure aerial conductor shall be continually insulated with a durable and efficient material to be approved by the Board of Trade to a thickness of not less than one-tenth part of an inch, and in cases where the extreme difference of potential in the circuit exceeds 2,000 volts, the thickness of insulation shall not be less in inches or parts of an inch than the number obtained by dividing the number expressing the volts by 20,000. This insulation shall be further efficiently protected on the outside against injury or removal by abrasion. If this protection be wholly or partly metallic it shall be efficiently connected to earth.

(34.) The material used for insulating any high pressure aerial conductor shall be such as will not be liable to injurious change of physical structure or condition when exposed to any temperature between the limits of 0° and 150° Fahr., or to contact with the ordinary atmosphere of towns or manufacturing districts.

(35.) Every aerial high pressure conductor shall be efficiently suspended by means of non-metallic ligaments to suspending wires, so that the weight of the conductor does not produce in it any sensible stress in the direction of its length, and the insulated conductors and suspending wires, where attached to supports, shall be in contact only with material of highly insulating quality, and shall be so attached and guarded, that in case they break away it shall not be possible for them to fall away clear of the support.

(36.) The undertakers shall be responsible for the efficiency of every support to which their aerial conductors are attached, and every such support shall be marked to indicate the ownership of the conductor.

(37.) Every aerial conductor belonging to the undertakers, including its supports and all the structural parts and electrical appliances and devices belonging to or connected with it, shall be duly and efficiently supervised and maintained as regards both electrical and mechanical conditions.

(38.) The undertakers shall not permit any aerial conductor to remain erected after it has ceased to be used for the supply of energy, unless they intend within a reasonable time again to take it into use.

*Penalties.*

(39.) If the undertakers make default in complying with any of the preceding regulations they shall be liable to a penalty not exceeding £10 for every such default, and to a daily penalty not exceeding £10.

The imposition of any penalty under this regulation shall not affect the liability of the undertakers to make compensation in respect of any damage or injury which may be caused by reason of such default.

*II.—REGULATIONS AS TO SUPPLY.*

(1.) One week at least before the undertakers are ready to commence to supply energy through any feeding, charging, or distributing mains, they shall serve a notice upon the County Council and the local authority of their intention to commence such supply.

(2.) From and after the time when the undertakers commence to supply energy through any distributing mains, they shall maintain a supply of sufficient power for the use of all the consumers for the time being entitled to be supplied for such main; and such supply shall, except so far as may be otherwise agreed upon from time to time between the County Council and the undertakers, be constantly maintained at such pressure as may be fixed under the provisions of these regulations. Provided that, for the purposes of testing, the authority by whom the electric inspector is appointed may give permission to the undertakers to discontinue the supply at such intervals of time and for such periods as it may think expedient, and that for any other purposes connected with the efficient working of the undertaking, the undertakers may, with the permission of the Board of Trade, discontinue the supply at such intervals of time and for such periods as the Board of Trade may think expedient. Where the supply is so discontinued, notice of such discontinuance, and of the probable duration thereof, shall be forthwith served upon the County Council and the local authority.

(3.) The system of distributing mains shall be so arranged in sections, that in case it becomes necessary to stop the supply through any portion of a main for more than one hour, for the purposes of repairs, or for any other reason, the stoppage of supply will in no case exceed in amount a maximum power of 200,000 watts, or extend to the premises of more than 80 consumers, and in the case of every stoppage for more than one hour, reasonable notice shall be previously given by the undertakers to every consumer affected thereby except in cases of emergency.

(4.) During the whole of the period when a supply of energy is required to be maintained by the undertakers in the distributing mains under the order and these regulations, it shall be maintained at a constant pressure (in these regulations termed "the standard pressure") to be fixed as hereinafter specified; but such standard pressure may be different for different portions of the distributing mains. Provided that the undertakers shall be deemed to have complied with the requirements of this regulation so long as the pressure does not at any point vary more than three per cent. from the corresponding standard pressure in the case of a general supply at low pressure, or two per cent. in the case of a general supply at high pressure, unless changes in pressure recur so frequently as to cause unsteadiness in the supply.

(5.) The standard pressure shall be fixed by the undertakers for every pair of distributing mains, and notice of the amount of such standard pressure shall be given to the County Council before the undertakers commence to supply energy to consumers through such mains, and such standard pressure shall not be altered except by permission of the County Council, and upon such terms and conditions as the County Council may impose, and after public notice has been given during a period of one month, in such manner as the County Council may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the County Council under this regulation to the Board of Trade, whose decision shall be final.

(6.) Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of consumer's terminals shall not, except by agreement, be greater than 115 volts or less than 45 volts, if continuous, or the equivalents thereof respectively, if alternating, and shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In distribution on the three-wire system, the central terminal shall for the purposes of this regulation be considered to form a pair with either of the outer terminals, and similarly for multiple-wire systems; and, in the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant pressure.

(7.) The variation of pressure at any consumer's terminals shall not under any conditions of the supply which the consumer is entitled to receive, nor at any time, exceed 4 per centum from the declared constant pressure, whether such variation be due to the resistance of the service lines or apparatus belonging to the undertakers, or to any action or effect produced by such apparatus, for which the consumer cannot be shown to be responsible, or, partly to any variation of pressure in the distributing mains from which the supply is taken.

(8.) If the undertakers make default in complying with any of

these regulations as to supply, they shall, subject to the provisions of the order, be liable to a penalty not exceeding £5 for every such default, and to a daily penalty not exceeding £5.

These regulations are made subject to the power of the Board of Trade to make such further or other regulations as they may think expedient; and nothing in these regulations shall be construed to authorise the undertakers to lay any electric line or work their undertaking otherwise than in accordance with the order and the principal Act, or to supply energy otherwise than by a system for the time being approved of by the Board of Trade under the order.

### ELIMINATING THE TEMPERATURE ERROR IN VOLTMETERS.

WE read the following in *L'Electrician*:—In all voltmeters based upon electro-magnetic action, the current passing through the bobbin depends on the difference of potential to be measured, and on the resistance of this bobbin. If this resistance is increased by heating, the instrument is retarded, and if when it has been calibrated the heating caused by a given difference of potential producing a continuous current in the bobbin has been taken into account, the voltmeter can only give exact indications on condition that practically the same voltage is always maintained at the terminals. In order to remedy this inconvenience, Dr. Kahle has conceived a method of winding the bobbins of voltmeters, which renders their indications independent of the temperature. This result is obtained by winding the bobbin with two parallel wires, acting in opposite directions. The principal wire magnetises, and the secondary wire demagnetises the core of the voltmeter; but as the auxiliary wire has a greater resistance than the principal wire, the magnetising action predominates. By taking for the principal wire a metal whose coefficient of temperature is higher than that of the secondary wire, we can easily see that a rise in temperature reduces both the magnetising action of the principal circuit and the demagnetising action of the secondary circuit. In order that the resulting electro-magnetic effect may remain the same, it is necessary that the difference between the ampère-turns of the two bobbins should be the same for all temperatures, a result which is obtained when the ratio of the two windings is the same as that of their coefficients of temperature.

It is evidently advantageous to employ for the principal wire a metal of low specific resistance, and for the auxiliary winding one of high specific resistance. As, however, the coefficient of temperature of good conductive metals is generally somewhat high, and that of bad conductors rather too low, the condition indicated above for establishing a system of compensation cannot be fulfilled without an accessory arrangement, which consists in establishing an external resistance, the coefficient of temperature of which is not very high, in series with the principal wire. Dr. Kahle has constructed, on these principles, voltmeters whose indications remain quite independent of the temperature.

**Telephones in New York.**—The Metropolitan Telephone Company of New York has the largest multiple switchboard in the world; it has a capacity of 6,000 metallic circuit subscribers, and at the present time is operating more than 3,800. The average daily number of connections made on this board is 48,238, and the average for the whole city is 103,621, about 98 per cent. of these connections being made between the hours of 8 a.m. and 6 p.m. In one station there are 128 operators, each of whom attends to between four and five hundred calls per day of 10 hours. The underground plant of the company has grown to a wonderful extent. There are in operation at the present time nearly 300 separate underground cables, each containing 50 twisted pairs of conductors, aggregating 145.5 miles of cable, or over 14,000 miles of wire. 140 of the 300 cables terminate at one office.

### LONDON COUNTY COUNCIL.

The weekly meeting was held on Tuesday last at Spring Gardens, with Sir John Lubbock in the chair.

The Highways Committee had considered a notice (Registered No. 119), dated 3rd October, 1890, of the London Electric Supply Corporation, of intention to lay distributing mains in Southwark Street, Blackfriars Road, and Borough High Street (1 plan). There appeared to be no objection to what is proposed, provided that the mains for Southwark Street be laid in the subway there. The committee recommended that the sanction of the council be given to the works referred to in the notice (Registered No. 119) of the London Electric Supply Corporation, dated 3rd October, 1890, upon condition that the company do give two days' notice to the council's engineer before commencing the works; that the mains for Southwark Street be laid and properly protected in the subway there; that the positions to be occupied by the mains in the subway be subject to the approval of the engineer of the council, and that the work of placing them be carried out to his satisfaction; that the mains in the other thoroughfares specified in the notice be laid under the footways, and be kept 9 inches below the underside of the pavement, wherever it is found practicable to do so, and that where the mains cross the carriage-ways, they be kept at the same depth below the concrete, or the road material, as the case may be; that the clerk be instructed to forward to the company a notice requiring it to lay the mains in Southwark Street, referred to in the notice dated 3rd October, 1890 (Registered No. 119), in the subway of that thoroughfare.

It was reported that during the present year testings made with the portable photometer in Bermondsey, Rotherhithe, Deptford, and Greenwich have shown the gas supplied by the South Metropolitan Gas Company in those districts to have been of deficient illuminating power. The testings, with but one exception, have shown the gas supplied to be of a less illuminating power than the company are required by their Act to supply. The nearest official testing stations to the districts in question are at Tooley Street, Peckham, and Plumstead, and it is clear that the large area between these stations is without any effectual check on the quality of the gas supplied. In these circumstances, they have directed the attention of the Gas Referees to the matter, and have requested them to prescribe an additional gas testing place in such a position as to ensure that gas supplied to the district in question is subject to official examination.

The weekly cash paper showed the following items:—

Maintenance of telephones and fire alarms	£1,800	0	0
Wadson, C. A.—			
c 954 Mounting plans, &c., re electric lighting testing, June, 1890	...	...	4 19 11
General Capital Account (Electric Lighting Testing)—			
India-rubber, Gutta Percha, and Telegraphic Works Co.—			
B 1920 Apparatus for testing station, Cranbourne Street, Sept., 1890	...	£198	15 1
Fletcher, T., & Co.—			
B 1921 Apparatus for testing station as above, June, 1890	...	3 18	3
			202 13 4
H.M. Postmaster-General—			
B 1969 Altering telegraphic pipes to suit new level of improvement at Mount Pleasant, Clerkenwell, June, 1890	...	66	2 5
Subscriptions for telephonic communication	...	5	0 0
Knight, J.—			
c 1218 Gas-fittings, electric light fittings, &c., for offices, Spring Gardens, March to June, 1890	...	107	6 1
Sax, J. (1504)—			
c 1153 Providing electric bells, June, 1889	...	10	13 6
Articles used for Electric Light Purposes.			
Harris, J. F. and G. (1569)—			
c 1157 Whitewood casing and cover, May, 1890	...	13	16 0
General Electric Co., Limited (1732)—			
c 1158 Blocks, shades, &c., March and May, 1890	...	6	10 0
Thompson, Ritchie and Co. (1578)—			
c 1159 Counterweight pendants and opal shades, June, 1890	...	9	16 6
Rashleigh Phipps and Dawson (1861)—			
c 1160 Counterweight, block, silk, and shade, May and June, 1890	...	3	18 10
Siemens Brothers and Co., Limited (1577)—			
c 1161 Cut-outs with bridges, June, 1890	...	2	5 0

## NOTES.

**Galway Electric Lighting.**—It may be of interest to our readers to know that there are being erected for the Galway Electric Company two 42-inch Hercules turbines giving from 75 to 90 H.P., with a fall of from 9 feet to 11 feet, to supply light and motive power for which there is a demand. The company has, since July 1st, been lighting the docks and other works, making use of an old flour mill machinery.

**Electric Light at Stockholm.**—Although detailed plans for the erection of the proposed electric central station which, like the gas works, is corporation property, have not yet been laid before the corporation, the latter has given permission to start the preparatory work, such as clearing away of old buildings from the site, &c. As usual, the estimated cost is now found to be too low, and the total expenditure will probably be nearer 2,000,000 kr. than 1,500,000 kr., the amount of the original estimate.

**Electric Lighting in Nelson.**—The gas committee of the Nelson local authority have received and approved the report of the gas manager upon a scheme of electric lighting for the town, and he has been instructed to get out specifications for the laying down of a cable, and other necessities, for an installation capable of producing 600 lights. At the last meeting of the board it was stated, in answer to a question, that the price of the electric light would be double that of gas, and while the latter was 2s. 6d. per 1,000 feet, the former would be 4s. 6d. for the same amount of illumination.

**Electric Lighting in Pemberton.**—The members of the Pemberton (Lancashire) Local Board have expressed themselves satisfied with the electric light trials, and the chairman of the board is of opinion the adoption of the system throughout the district is only a question of time.

**The Lineff Traction System.**—Colonel Huber, of the well-known Oerlikon Engineering Works, last week inspected the experimental line on the Lineff system at Chiswick. Negotiations were commenced on behalf of the Oerlikon Company with a view to obtain a license from the Lineff Syndicate for various continental countries. We understand that a powerful combination is to be formed for the purpose of working the invention in France. With regard to the application of the system on the West Metropolitan tramways, we are informed that the Hammersmith Vestry has decided to grant the application, subject to a favourable report being received from an expert whom they will appoint.

**Meters.**—It would be interesting to ascertain how many electricity meters are in use in London. According to a recent return regarding the Geneva Central Station, 450 Aubert meters and 65 Aron meters are in operation; yet the number of incandescent lamps in daily service is only 5,375, of which 2,433 are located in the theatre and the remaining 2,942 are distributed among 216 subscribers. We wonder whether London, with all its central stations, can total 515 meters in use.

**The Tudor Accumulator.**—The use of Tudor accumulators in Germany has been greatly extended during the past few years. So much has this been the case that the makers, Messrs. Müller and Einbeck, of Hagen, resolved to open branch works in Austria, and the accumulator factory of Messrs. Getz and Odendall has just been acquired for that purpose.

**A Long Electric Line.**—An American contemporary says:—A notable installation is about to be made between Seattle and Tacoma, a distance of 42 miles. This will be the longest electric railway in the world.

**The Central Institution Students.**—Of the 100 odd candidates who entered at the end of September for the Matriculation Examination at the City and Guilds Central Institution 60 passed, and 16 did sufficiently well to be allowed to enter the college as unmatriculated students. In addition to the regular students of the second and third years, and the 76 above referred to, who are admitted to attend courses in *all* the four departments of mathematics and mechanics, engineering, physics and chemistry, some 20 special students have entered for portions of the advanced courses in one or more of these departments. On the result of the entrance examination the Clockworkers' Scholarship of £60 a year, with free education, tenable for two years and renewable for a third, was gained by C. E. Stamp, from St. Paul's School, and the three Institute's Scholarships, each of sufficient value to cover the students' fees for three years at the Central Institution were gained by G. H. Baillie, from Winchester House School, C. V. Drysdale from the Finsbury Technical College, and A. E. Sonneborn from Tottenham College. At the end of last session the John Samuel Scholarship, granted to a meritorious student of the Central Institution at the close of his second year's course, and consisting of £30 and free education for the third year, was awarded to C. W. Clinton; the Siemens medal, given to the students of greatest merit in the department of Electrical Engineering, was taken by R. Wightman.

**Faure-Sellon-Voelckmar Cells.**—A well-illustrated pamphlet, which is being distributed by the *Bulletin International de l'Electricité*, has been published by the Société Française d'Accumulateurs Electriques, describing these well-known accumulators (E.P.S. type). Details are given regarding the construction of the cells, their methods of use, applications for lighting or as regulators, and to traction purposes. A perspective view is given of one of the accumulator cars now in service on the Levallois-Madeleine Tramway, which was described in the REVIEW some time ago.

**Priestman's Petroleum Engines.**—We learn that a gold medal for these oil engines has been awarded at the Edinburgh Exhibition.

**Telephony in Scotland.**—The Glasgow Committee of the Mutual Telephones Company, Limited, has decided to adopt the metallic system for Scotland, so as to enable subscribers to speak over long distances, as, for instance, between Glasgow and Manchester and London. The new system is proposed to be inaugurated with the new year.

**A Runaway Electric Car.**—The *Birmingham Post* of the 14th inst. says:—The passengers by the Bristol Road tram, leaving Navigation Street at 7.45 last evening had a very narrow escape. As soon as the car began descending Suffolk Street it was evident that something was wrong, and as the driver kept ringing his bell, and the speed of the tram increased, it became evident that he had lost control of it. The heavily-laden car went down the hill at a fearful pace, and threatened to upset as it passed from the double to the single line. The progress of the car was watched with intense anxiety, as the crossing at the bottom of Holloway Head is a most dangerous one. By the regulations of the company the car should be stopped at the bottom of Suffolk Street, but it was apparent that for some reason or other this was impossible, and a collision with the many vehicles about seemed all but inevitable. Fortunately, however, everything was cleared out of the way, and the tram brought to a standstill by the cabstand, very much to the relief of the occupants. What was the cause of the incident could not be gathered beyond that there was some defect or other with the brake-power. The name of the driver was taken by a police-officer, and the rest of the journey was performed under less exciting circumstances.

**Telephones in Sweden.**—Although the Swedish telephonic system is probably unrivalled, the Swedish engineers evidently do not mean to rest on their laurels. The Swedish Government has placed a sum of 1,600 kr. at the disposal of the State telegraphs, asking them to send a suitable man to Holland, England, and America, in order to see whether any improvement has recently been made in telephones.

**Gold Medal.**—Messrs. Davis and Timmins, of Hatton Garden, have been awarded a gold medal by the jurors of the Edinburgh Exhibition for general excellency of manufactures.

**Literary Announcements.**—Messrs. Crosby, Lockwood & Co. announce a fourth edition of "Electric Light: Its Production and Use," by J. W. Urquhart.

**City and South London Railway.**—The *Financial News* says some of the shareholders in the City and South of London Railway are beginning to ask when their underground electric railway from King William Street to Stockwell will be inaugurated. The chairman of the company has frequently assured them that the line "is expected to be opened shortly," and that most of the machinery and rolling stock is already to be found at the Stockwell depôt. A visit will, however, convince anyone that the railway and plant are not in such a forward condition as would appear from the chairman's statements. As over £650,000 has already been sunk in the undertaking during the past four years, it is quite time the railway was opened.

**Copper.**—Production of copper ore from the mines of the Canadian Copper Company, Sudbury, Ont., for the last year is officially stated to be 60,000 tons. Copper shares are not in a good position, according to the dealings on the French Bourse. The feeling of speculators is that copper shares are going lower.

**The New Cables between Peru and Chili.**—As foreshadowed in our "Notes" of last week, the cable steamer *Silvertown* left Greenhithe, on October 11th, for the West Coast of South America. On the preceding day a large company of guests were invited to luncheon on board, to bid farewell to their friends, and to wish the expedition God-speed. The ship takes out about 1,750 nautical miles of submarine telegraph cable, weighing about 2,700 tons, and the total cargo carried, including coal, cable, provisions, and general stores, weighs somewhat under 5,000 tons, a comparatively light burden for this vessel, whose capacity is nearly 7,000 tons. The cable was manufactured by the Silvertown Company for the Central and South American Telegraph Company, and is to be laid from Chorillos, near Lima, Peru, to Yquique, the well-known nitrate port, and thence to Valparaiso, the principal port of Chili. More direct and rapid communication than now exists will be thus secured between the points mentioned, since the present cables owned by the West Coast of America Telegraph Company, and laid in 1875, touch at many intermediate places along the coast between Lima and Valparaiso. The Central and South American Company, by means of their cables from Lima northwards along the West Coasts of South and Central America, their land line across the isthmus of Tehuantepec, and their cables across the Gulf of Mexico, will, on completion of the new lines, have communication over their own systems from Valparaiso to the United States. The total complement of persons on board amounts to 144, roughly divided into: Staff, officers, and engineers, 23; cable hands, 40; crew, stewards, &c., 59; stokers, firemen, &c., 22. The expedition is under the direction of Mr. M. H. Gray, engineer-in-chief, and Mr. J. R. France accompanies the ship as representative of the Central and South American Telegraph Company. The trip is expected to last between five and six months, including voyages out and home (about 9,000 miles each way), sounding work, cable laying, term of guarantee, and possible delays. We wish the expedition every success.

**Vestries and Electric Mains.**—Major C. B. Waller, the manager and secretary of the London Electric Supply Corporation, was summoned by the Vestry of St. George the Martyr, Southwark, on Wednesday, for that "he did cut away and take out part of a sewer in Union Street, Borough, for the purpose of laying mains for electric lighting without first having obtained the permission of the vestry." The surveyor of the vestry discovered a week or so since that the Corporation had cut away a portion of a sewer for the purpose of carrying their mains over it. For the defendant it was urged that the vestry had no power to interfere, and in the end Mr. Slade adjourned the summons to give both parties an opportunity of referring the matter to the Board of Trade.

**The Popularity of Electrotechnics.**—The total number of students receiving electrical instruction in the Finsbury Technical College (day and evening) to date, this session, is 595, of whom 444 attend laboratory work. If similar Institutes are filled in a like proportion we shall soon have that old question of "What shall we do with our boys" raised again."

**Removal.**—Mr. Carl Oppermann informs us that he has removed his business from 41, Sigdon Road, Hackney, to 2, Wynnatt Street, Clerkenwell, E.C.

**Business Mention.**—Messrs. O. Berend & Co. have shown us some really good designs in electroliers in bronze and majolica; in fact, more tasteful specimens we never saw. The price is said to be very moderate.

**The Pacific Cable.**—We extract the following from the *Evening News* of October 11th: "Sir John Pender, the 'Cable King,' has arranged to pay a visit to the Pacific side of the world next year, and he has already apprised Mr. Sandford Fleming, the Austral-Canadian cable enthusiast, that he will then be prepared to discuss the feasibility of establishing cable-graphic communication between Vancouver and the Antipodes. It is evident from this that Sir John and his colleagues have come round to the point of recognising the necessity for an alternative cable to Australia by way of the Pacific. The fact of the whole matter is, that the Eastern Telegraph Company, true to the national instinct of self-preservation, have realised that if their monopoly of the cable business is to be maintained, they must step in and lay the Pacific cable. The last total interruption of the whole of their cables between here and Australia had the effect of producing a strong feeling in the colonies in favour of the long talked of Pacific cable as an alternative line in case of a recurrence of such accidents, and there can be no doubt that if Sir John Pender and his friends display any tardiness in taking the matter up, somebody else will do the work before long.

**Running Alternators Parallel.**—At a late hour we have received a very interesting letter on this subject from Mr. Hooker, electrician to the Bath Electric Light Works, who has been running Mordey alternators in parallel in a most satisfactory manner. As a drawing accompanies his communication, we must reserve it till next week.

**Sales of Electrical Plant, &c.**—It will be noticed in our business columns that a stock of "Lever" arc lamps and the patent rights for England and abroad are offered for sale. The electrical plant used for lighting the House of Commons is also to be put up to public auction.

**To A. E. M.**—The patent specification in which the form of magnet used in the Gower-Bell telephone receiver is first described, is No. 315, dated 25th January, 1879, and it does not appear that any claim is made in the same for the particular form of magnet and coils used; on the expiry, therefore, of the Bell patent in December, this form of magnet for telephonic purposes becomes public property, though probably this might be contested by the owners of the patent.

**Edinburgh International Exhibition.**—The Royal Scottish Society of Arts held a special session at the Exhibition on October 13th, under the presidency of Lord Kingsburgh. Five papers were read, three of which were electrical, viz., "On the Telegraphic Exhibits," by Prof. Grant-Ogilvie; "Telpherage and Electric Railways," by Mr. E. Manville; and "Electrical Navigation," by Mr. A. R. Bennett. There was a large attendance of members. In moving a vote of thanks to the authors, Lord Kingsburgh regretted that the electrical industries had, so far, met with scant recognition in Scotland, and expressed a hope that the abundant water supplies in the Highlands would soon be turned to useful account in providing light and power to the various cities and towns. The members afterwards took trips on the telpherway and electric tramway and in the electric launches; and a special vote of thanks was accorded to Mr. Bennett, to whose invitation the meeting had been due.

**Steam Pipe Covering.**—Messrs. A. Haacke & Co. have received a silver medal at the Edinburgh Exhibition, where they covered the main steam pipes with their pyrostat composition. This is a non-conducting composition, and can be applied even to red-hot surfaces, and is specially adapted for covering boilers and steam pipes containing 150 to 200 lbs. pressure.

**Electric Lighting.**—The Town Council of Paisley have agreed to apply to the Board of Trade for a provisional order to supply electric lighting for private and public purposes within the burgh.

**Pictorial.**—It is not often our lot to view a combination of things electrical and pictorial; indeed it is generally considered that machinery of any description absolutely refuses to lend itself to any effort of a picturesque nature; but a day or two since we were invited to view a portrait of Mr. Thomas Parker, of Wolverhampton, and promptly responded in person to the invitation. On arriving at the studio of the artist, Mr. E. Goodwyn Lewis, at No. 17, Fitzroy Street, we were surprised to find a fine painting representing not only Mr. Parker but that gentleman surrounded by machinery and electrical instruments, as if in the works at Wolverhampton. Through an open window is well shown and judiciously treated a tram-car, and the electric light is freely displayed, the whole being painted as illuminated by that light. It is an important work, bristling with difficulties, which the artist must be credited with having overcome in a remarkable degree. We may add that the work has been executed for Mr. Oddie, of Ballarat, Australia, who intends presenting it to the Ballarat Art Gallery, art and electricity both being among the donor's favourite pursuits.

**Submarine Telephonic Communication.**—The German Post Office officials have been experimenting during the last few days with the North Sea cable, 75 kilometres long, between Heligoland and Cuxhaven, to test the possibility of using submarine cables of considerable length for telephonic purposes. The results have been very favourable, distinct communication having been obtained at both ends.

**Personal.**—Mr. Oswald Haes, who is an old student of Finsbury Technical College, and has been on the engineer's staff of the Brush Electrical Engineering Company and its predecessor, the Anglo-American Company, for three years, has been appointed to the management of the engineering department of the company's branch in Australia, and is shortly proceeding to Sydney, N.S.W., to take up his position.

**Electric Lighting for Lewes.**—At a largely-attended meeting of Lewes ratepayers, held on Wednesday night, under the presidency of the Mayor, it was decided by an overwhelming majority to adopt electricity for street lighting.

**Business Extensions.**—Messrs. Paterson and Cooper inform us that they have opened a West-end showroom at 3, Prince's Mansions, Victoria Street, Westminster, where it is proposed to keep samples of manufactures.

**The Eight Hours Bill.**—Mr. R. W. McLeod Fullerton, Unionist candidate for the East Division of Edinburgh, addressing the electors, said he supported the right of the individual to freedom of action and making of contracts; but to the general principle he would make exceptions, such as in cases where there was a temptation both to employers and employed, or to either, to make agreements which were prejudicial to the health and comfort of the workman. He pointed to the case of the telegraph offices in large towns, where seven hours' work a day was as much as the telegraph clerks could stand. He would be in favour of a commission of inquiry as to the amount of work in the various telegraph offices in the country, with the view of determining in what offices a compulsory seven hours day should be fixed.

**Electrolysis versus Paracentesis in Ovarian Cysts.**—Dr. Sigmund Cserey, writing in a Hungarian medical journal, points out the great advantage that electrolysis possesses over paracentesis in ovarian cysts where more radical operative measures are for any cause inadmissible. The enormous loss of albumen by tapping is frequently followed by serious weakening of the patient, which is not the case where electrolysis is employed, this method causing the proteid to be partially re-absorbed by the system. He mentions a case where an ovarian cyst had been tapped twelve years previously, but had very soon filled again. Since then electrolysis had been several times employed with far more lasting results. He used a 20-cell Smee's battery, the anode being a needle, which was inserted into the abdomen to the depth of 3 inches and a half, and the cathode, a large flat surface, applied to the lower part of the back. The circuit was opened with two cells, and gradually raised to 14, which caused so severe a burning pain that the number was reduced. The whole sitting lasted 35 minutes. The good effects were soon seen in the increase of the urine and the decrease of the circumference of the abdomen.

**A Novel Use for the Electric Motor.**—The convenience of the electric motor is being shown to crowds who watch the Sioux City Corn Palace, now in course of construction. About 15,000 bushels of corn are used to decorate the building. Last year the saws to split the corn were run by four horses, and the irregular speed caused much annoyance. This year a 3 H.P. Hawkeye electric motor belted direct to a saw does all the work much more satisfactorily, one man sawing about 60 bushels an hour, to supply over 200 men and about the same number of women, who are decorating the building. For working at night the immense structure is illuminated by 50 arc lights and over 1,000 incandescents.

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#### NEW COMPANIES REGISTERED.

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**Henry Leggott & Co. Limited.**—Capital, £20,000 in £10 shares. Objects: To trade as electrical engineers, iron and brass founders, and to take over the business of Henry Leggott and Co., ironmongers, domestic, sanitary and gas engineers. Signatories (with 1 share each):—\*J. R. Cordingley; E. Greaves; J. L. Wilson; \*J. R. Birkinshald and J. J. Colefax, all of Bradford; \*Hy. Leggott, Hepperholme; \*R. Leggott, Harrogate. The signatories denoted by an asterisk are the first directors. Qualification £500 in shares or stock, remuneration £1 ls. each for every meeting attended. Registered 7th inst by R. Jordan, 120, Chancery Lane. Registered office, 73, Market Street, Bradford.

**Cape Town and District Gas Light and Coke Company, Limited.**—Capital, £100,000 in £10 shares. Objects: To purchase the gas works of the Cape Town Gas Light Company, Limited, and to carry on the business of the same. To carry on the Cape Town and its districts, and in South Africa, England and elsewhere, the business of an electric lighting and power company in all branches, including the manufacture, sale, and supply of electricity for light, motive power, and other purposes. Signatories: \*R. A. Fairclough, 14, Bunhill Row; \*J. Boustead, 34, Craven Street; \*H. R. Savory, 11 & 12, Cornhill, 100 shares each; Wm. Lewis, D. Sluter, F. H. Leslie, J. A. Kelman, all of 251, Winchester House, 5 shares each. The first directors are the signatories devoted by an asterisk, and the Hon. Hy. Noel. Qualification, £1,000 in shares. Remuneration, £1,200 per annum divisible. Registered 9th inst. by Paine, Son & Pollock, 14, St. Helen's Place.

### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**International Okonite Company, Limited.**—An agreement of 18th July between Woodhouse and Rawson United, Limited (the vendors) and this company, cites that by an agreement of 24th June it was agreed that the vendors should sell to the company the business and properties therein described for £324,990, of which £113,330 was to be payable by the allotment of fully paid preference and ordinary shares, the amount of such shares respectively to be fixed by the vendors, provided that not less than £50,000 of either description be allotted. Under the present agreement the vendors fix the amount to be allotted in preference shares at £61,160, and the amount to be allotted in fully paid ordinary shares at £52,170.

An agreement of 30th July between the same parties provides that the proportion of the purchase money payable in shares shall be £113,320 instead of £113,330, and payable £56,660 in fully paid preference shares and £56,660 in fully paid ordinary shares.

**Mulholland, Maugham and Company, Limited** (mechanical and electrical engineers).—An agreement of 14th August, filed 27th ult., relates to the purchase by the company of the Mulholland, Maughan & Co., of West Carnforth, Durham, the consideration being the allotment of 120 fully paid £10 founders' shares, which will be entitled to one-half the surplus net profits remaining after payment of  $7\frac{1}{2}$  per cent. per annum dividend upon all the shares.

**Northern Counties Electric Light and Power Supply, Limited.**—The registered office of this company is situate at 13, Victoria Street, Westminster.

**Grange Syndicate, Limited** (Groth's Electric Tanning System).—The registered office of this company is situate at 3, Tokenhouse Buildings, Bank, E.C.

**Weston House-to-House Electricity Supply, Limited.**—The registered office of this company is at 13, John Street, Bristol.

**Paddington and Bayswater Electric Light and Power Supply, Limited.**—The registered office of this company is situate at 13, Victoria Street, Westminster.

### CITY NOTES, REPORTS, MEETINGS, &c.

#### Woodhouse and Rawson United, Limited.

At the general meeting of the shareholders, held at Winchester House, on Friday, the 10th, Lord Aberdare presided, and in moving the adoption of the report and accounts, said: There were two points in the former to which he desired to call attention. The first was that the ordinary shares, of which one-half

remained uncalled, were those that were taken by the public; the shares allotted to the vendors, and which of course were fully paid, stood in the balance sheet. As regards the other point, the report mentioned that the Sociedad Española de Electricidad, in Barcelona, had placed the whole of its arrangements for improving and extending the lighting of that city by electricity in the hands of the company. The contract had been made with Woodhouse and Rawson, Limited, and it had been taken over by the present company, and at the present time the Barcelona Society was engaged in carrying out the company's suggestions. A board of directors might present its report in two ways: it might present the report and resolutions in the briefest and most succinct form, leaving it to the Chairman to supply any special facts and explanations which might be called for; or the report might take the form of a detailed account of the company and its development and its prospects for the future. The directors of Woodhouse and Rawson United, Limited, had chosen to take the latter course, which has the further advantage that it relieved the chairman from making a very long speech. Those who had carefully studied the report would see how numerous and important the operations had been. To some they might seem incongruous, but a little reflection would show that in reality there was a close connection between them. The manufacturing, supply and contract departments explained themselves. The development of the business, the taking over and bringing out of new inventions by the purchase of patents or of manufacturing under royalties to inventors formed a large and lucrative portion of the business, as also did that portion of the business which consisted in aiding in the formation of companies which require capital beyond their means, and experience which they did not possess. All these branches of electrical business were undertaken by the several companies purchased by and absorbed into this company. They had in their various departments been extended as rapidly as the short period of the company's existence permitted. The manufacturing, supply and contract departments had made considerable improvement in actual performance, and gave what the speaker ventured to call a well-grounded promise of further extension. Altogether the report presented a picture of great activity which, with time and opportunity, could be greatly extended. In his opinion to the three branches, manufacture, supply and contract, was due the solid basis upon which the ultimate success of the company should rest. Obviously expectations of large profits from those sources could only be gradually realised. They must sow before they could reap. It would be unusual and, he thought, inadvisable to enter minutely into the source of profits in the case of a manufacturing company like this. But this much he might say: the large profits of the present year had enabled the directors to recommend a dividend of 15 per cent. per annum without availing themselves of the £75,000 deposited by Woodhouse and Rawson, Limited, to guarantee that amount of dividend for three years, had enabled the directors to place £25,000 to the reserve fund, to carry forward over £16,000 to next year's accounts, and to write off £7,421 against the estimated value of the patents. These large profits had been mainly derived from the fourth branch of the company's business, viz., the testing and approving of new patents and inventions connected with electrical and engineering science, and their introduction to the public either by making arrangements for working them, or by assisting the owners and inventors in forming separate companies for that purpose. Such were the operations of Woodhouse and Rawson, Limited, in introducing the Elmore process, which the present company was, with every prospect of success, extending over the chief commercial centres of Europe; the International Okonite Company, the West Kensington Co-operation Stores, &c. That there was a certain risk involved in the introduction of new inventions it would be absurd to deny, but he could honestly say that the operations referred to had never been undertaken without the most careful enquiry that the judgment, experience and knowledge of firms possessed by the board had been able to exercise. They represented, in fact, a very small proportion of the proposals made for the board's assistance in one form or another, the vast majority of which had been rejected, because the board limited itself to the selection of such as seemed thoroughly sound and of intrinsic value. It was a mere act of justice to the managing director, Mr. F. L. Rawson, to say that the success hitherto attained had been mainly owing to his initiative, and the extreme energy and ability he had displayed. Neither could the speaker refrain from expressing his personal sense of gratitude to their vice-chairman, Sir Rawson W. Rawson, for his great exertions and the unlimited attention to the affairs of the company, especially during the period of severe illness which he, the speaker, had undergone. To his other colleagues, also, he tendered his grateful acknowledgments. The report spoke in by no means exaggerated terms of the unusual demands which had been made upon the time of the staff, owing to the pressure involved in a new company engaged in such extensive operations, and the speaker begged to add his own acknowledgments of the way in which the staff had performed its duties, and to warmly recommend the adoption of the resolution for the formation of an employe's pension fund. Might he be permitted to make some suggestions which were the fruit of past years' experience. First, he thought it very desirable that the company's capital should be increased, and he trusted that the board would ere long submit resolutions with that object. The report told them that the directors had already considerably extended the business and the business premises of the company, but he must tell them that these extensions could not be fully developed nor made as profitable as they might without an addition to the working capital. At present

they had the use of the £75,000 deposited with them by Woodhouse and Rawson, Limited, but that would have to be repaid two years hence at the latest. It might be worth while to do so earlier, if satisfactory arrangements could be made with the liquidators, to whom doubtless it would be of great advantage also. That was a matter for the future; still he thought it advisable to prepare the shareholders for possible proposals in that direction. His other suggestions related to an increase in the numbers of the board and working staff. He had already referred to the heavy responsibilities which had rested upon the board, which consisted, he might say, of seven only during the past year, in the conduct of the company's general business, and in sifting the various schemes brought before them, and he need not enlarge further upon that point. Such a business could not be properly carried on without great expenditure of time and labour, and long and frequent discussion. He saw little probability of a diminution of the directors' work in the near future, and he did not think that the present pressure upon them could long be continued, or that it ought to be. He would, therefore, venture to suggest the increase of the board to nine, the full number authorised by the articles of association, and that the directors' remuneration also should be increased by the allowance of a percentage on the net profits of the year. The present remuneration was inadequate to gentlemen who are obliged to give so large a part of their time to the superintendence of this great and growing business. As regards the working staff, with the best will in the world the board of directors could be little more than a consultative body; the initiative, no less than the details of the company's operations, must rest with the executive staff. Theirs was an excellent one so far as it went, but no man ought to be called upon to do all the work which at present fell upon many of the company's officers, and more especially upon the managing director. There ought to be some further division of labour, the cost of which would be inconsiderable as compared with the increased efficiency in the external and internal management. It only remained to thank the meeting for the patience with which they had listened to his remarks, to echo the congratulations of the report upon the company's achievements in the past year, and its present position and prospects, and to express the earnest hope that the shareholders would with a unanimous vote support the board in its efforts to give stability to an enterprise which had begun so well. He trusted the reasons given in the report for his resignation would be thought sufficient, and he congratulated the shareholders on the new director proposed for their acceptance. The high character of Sir Edward Thornton for ability and honour in his past career as a foreign minister was well known, and he hoped they would re-elect Sir Rawson Rawson as a director. It was the board's intention to request Sir Rawson Rawson to assume the chairmanship, and he need not say that he entirely concurred in the choice made. In conclusion, he was happy to announce that the affairs of the Woodhouse and Rawson Company, Limited, might now be considered as settled, after long and vexatious endeavours to bring that settlement to an earlier conclusion, and he was happy to hear that the shares were already on their way to the various long-expectant shareholders.

Sir Rawson Rawson seconded the motion. He said invention in the present day in connection with electricity was advancing so rapidly, that it only required energy and prudence on the company's part to ensure numerous offers of most valuable inventions. They had now in course of examination and testing some exceedingly valuable patents.

A Shareholder noticed in the balance sheet that the number of ordinary and of fully paid shares issued amounted to 34,633, whereas on January 29th the company issued a statement to the effect that 36,316 had been issued. He would like to know, also, whether £31,000 was not an unusual amount of cash to keep in hand.

Mr. F. L. Rawson, with regard to the first question, said the shareholders might be assured that whatever statements had been made they were absolutely correct. As regards the other point, the explanation was that a cheque for £30,000 had not yet been paid into the bank when the balance sheet was made up, but was paid immediately afterwards.

Another Shareholder pointed out that that some of the vendors' shares had not yet been allotted.

The Chairman said they had now been allotted. The delay was owing to the directors having had to wait for the liquidator's instructions of Woodhouse and Rawson, Limited.

Another Shareholder asked what proportion of the £91,000 and odd put down as profit was *bona fide* trade earnings?

The Chairman declined to enter into questions of that kind. It was not, he considered, in the interests of the company to give these explanations, although the questions occurred very naturally to the shareholders.

Mr. F. L. Rawson, replying to another shareholder, said that he expected that the Stock Exchange would grant the company a quotation in about a week's time.

The resolution was agreed to.

The Chairman then moved to declare dividends at the rate of  $7\frac{1}{2}$  per cent. and 4 per cent. on the preference shares, making, with the interim dividend of  $7\frac{1}{2}$  per cent. already paid upon the ordinary shares, and 4 per cent. already paid upon the preference shares a dividend of 15 per cent. per annum on the ordinary and of 8 per cent. per annum on the preference shares. He observed that the 7 per cent. preference shares were entitled to an extra 1 per cent. each year that the ordinary shareholders received 10 per cent. per annum.

Sir Rawson W. Rawson was re-elected a director, and Sir

Edward Thornton was elected a director in the place of Lord Aberdare. Messrs. Pixley & Co. were reappointed auditors at a remuneration of 100 guineas.

A resolution to increase the directors remuneration from 30th June, 1890, by a commission of 2 per cent. on the net profits of the company was agreed to unanimously.

Mr. Pope, Q.C., one of the directors, in the course of a few remarks said it might interest some shareholders to know that Mr. Philip Rawson, one of the directors, was in no way related to Sir Rawson Rawson. As representing the general body of the shareholders he, Mr. Pope, would jealously watch anything like a family party administration in a concern of this magnitude, and from his continuing to hold his place on the board, the shareholders might be satisfied that no such disposition had been manifested. After praising Sir Rawson Rawson's self-sacrifice and attention to the company's affairs, and expressing regret at Lord Aberdare's retirement, he went on to say that, of course, no one would imagine that £91,000 a year profit was one that could be made by the manufacture and supply of electrical apparatus. As one connected with other electrical companies, he knew pretty nearly the scale of profit to be made in such businesses. It would not be desirable to disclose to competitors the exact amount of profits the company made. It they were very large, it would provoke competition; if small, it would disclose an unfortunate state of affairs. The shareholders might be well content with what had been placed to their credit, without being very anxious to enquire into the particular source of profit. But he strongly advised them to see at all times that the profits were real. They must be well content that they were receiving 15 per cent. upon money which had only been invested for about twelve months. He advocated the maintenance of a strong reserve against contingencies. A business like this was, after all, not so steady as an ordinary trading concern; it must be more or less speculative. Since the balance sheet was made the company's profits had not fallen off. To Mr. F. L. Rawson was due the remarkable energy, and to Lord Aberdare and Sir Rawson Rawson the prudence with which the companies affairs had been conducted.

Mr. F. Rawson spoke of the *employés* pension fund as an inducement to *employés* to remain in the company's service, and said that probably the shareholders would be asked at a general meeting to sanction the scheme. With a vote of thanks to the board, and to Lord Aberdare in particular, the proceedings terminated.

### The Brazilian Submarine Telegraph Company, Limited.

THE report of the directors and the accounts for the half-year ended 30th June, 1890, to be submitted to the 34th ordinary general meeting, 22nd October, 1890, states that:—

The directors submit the annexed accounts and balance-sheet for the half-year ended 30th June, 1890.

The revenue for this period amounted to £121,873 19s. 9d., and the working expenses to £16,492 5s. 3d. After providing £12,880 for debenture interest and sinking funds, and £1,559 17s. 1d. for income tax, there remains a balance of £90,941 17s. 5d.; to this is added £9,975 0s. 8d. brought forward from 31st December last, making a total of £100,916 18s. 1d. A quarterly interim dividend amounting to £19,500 has been paid, and £40,000 transferred to the reserve fund, increasing that fund to £352,626 2s. 11d.

The directors now recommend the declaration of a final dividend of 3s. per share, making with the interim dividends, a total dividend of 6 per cent. for the year, and also the payment of a bonus of 3s. per share, both free of income tax, which together will amount to £39,000, being a distribution in the aggregate of  $7\frac{1}{2}$  per cent. for the year ended 30th June, 1890, leaving a balance of £2,416 18s. 1d. to be carried forward. The dividend and bonus will be payable on the 23rd instant.

On the 31st July last the sum of £15,300 was transferred to pay off the 153 bonds of the 1884 issue, drawn for redemption in April last. This repayment reduces the debenture debt to £144,200.

The receipts for the half-year include the sum of £1,500 dividend to 31st December, 1889, on the company's shares in the African Direct Telegraph Company, Limited.

The various sections of the company's line are in good working order.

Sir James Anderson and Mr. Frederick Youle retire by rotation at this meeting, and being eligible for re-election as directors offer themselves accordingly.

The two auditors, Mr. Henry Dever and Mr. John Gane, also offer themselves for re-election.

### The Direct United States Cable Company, Limited.—

The board has resolved upon the payment of an interim dividend at the rate of  $3\frac{1}{4}$  per cent. per annum, for the quarter ending 30th September, 1890.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 10th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,21.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (October 9.)	Closing Quotation. (October 16.)	Business done during week ending October 16, 1890.	
£					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	98 — 101	99	...
1,549,160	Anglo-American Telegraph, Limited	Stock	50½ — 51½	49½ — 50½xd	49½	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	87 — 88	85 — 86 xd	86½	85½
2,725,420	Do. do. Deferred	Stock	14½ — 14½	13½ — 14½	14½	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12½	11½ — 12½	12½	11½
99,000	Do. do. 5 p. c. Bonds	100	100 — 102	100 — 102	100	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 2	1½ — 1½	...	...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 1½	1½ — 2	...	...
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104	103½	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	½ — ½	½ — ½	...	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½	...	...
16,000	Cuba Telegraph, Limited	10	11½ — 12½	11½ — 12	11½	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited	5	4 — 4½	3½ — 4½xd	4	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 — 14½	13½ — 14½xd	14½	13½
70,000	Do. do. 6 p. c. Preference	10	15 — 15½	14½ — 15½	15½	14½
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	107	...
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	104 — 107	104 — 107	106½	...
1250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14½ — 14½	14 — 14½xd	14½	14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102	...	...
446,100	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs.	100	102 — 105	102 — 105	...	...
12,500	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drawings	100	102 — 105	102 — 105	102½	...
367,900	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900	100	101 — 104	101 — 104	103½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8½	7½ — 8	7½	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½	...	...
46,700	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5½	5 — 5½	5½	4½
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid)	2	2½ — 2½	2 — 2½	...	...
19,700	Fowler-Waring Cables, Nos. 301 to 20,000	5	2½ — 3	3½ — 4	...	...
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	8½ — 9½	8½	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15	14½ — 15	15	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	16½	15½
15,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104	...	...
230,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107	104	...
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½	...	...
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½	...	...
41,600	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 — 19	18½ — 19½	...	...
200,000	Do. do. 4½ p. c. Deb., 1896	100	102 — 104	100 — 102 xd	...	...
17,000	Indo-European Telegraph, Limited	25	36 — 38	36 — 38	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6½ — 7½	...	...
100,000	Do. do. do. 6 p. c. Debentures	100	105 — 108	105 — 108	...	...
49,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5½ — 6½	5½ — 6	5½	...
436,700	National Telephone, Limited, Nos. 1 to 436,700	5	4½ — 4½	4½ — 4½	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 12½	12½ — 12½	...	...
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	9½ — 10½	...	...
1220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	½ — ½	½ — ½	...	...
9,000	Reuter's, Limited	8	8½ — 8½	8½ — 8½xd	...	...
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	½ — ...	½ — ...	...	...
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3	...	...
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117	...	...
78,949	Swan United Electric Light, Limited	5	5½ — 5½	5½ — 5½	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	44½	...
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	...	...
55,000	United River Plate Telephone, Limited	5	3½ — 4	3½ — 4	...	...
146,000	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94	...	...
100,000	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8½ — 9½	...	...
300,000	Do. do. do. 5 p. c. Debentures	100	98 — 101	98 — 101	99	...
30,000	West Coast of America Telegraph, Limited	10	4½ — 5	4½ — 5	...	...
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	102 — 107	102 — 107	103½	...
64,572	Western and Brazilian Telegraph, Limited	15	11½ — 11½	11½ — 11½	11½	...
26,986	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7½	6½ — 7½	6½	...
26,986	Do. do. do. 5 p. c. Deferred	7½	4½ — 5½	4½ — 5½	4½	4½
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106	...	...
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106	...	...
88,321	West India and Panama Telegraph, Limited	10	2½ — 3½	2½ — 3½	2½	...
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 12	...	...
4,669	Do. do. do. 6 p. c. 2nd Preference	10	14 — 15	14 — 15	...	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	122 — 127	122 — 127	...	...
179,300	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103	...	...
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	1½ — 1½	2½ — 3	...	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 1½—1½.—House-to-House Company (£5 paid), 5—5½.—International Okonite, Ordinary of £10 (£7 paid), 6½—7½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/-—13/-.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 439.)

Now the law of traction being in that way established, one at once begins to get some light upon the subject of the design of electro-magnets. Indeed, without going into any mathematics, Joule had foreseen this when he in some instinctive sort of way seemed to consider that the proper way to regard an electro-magnet for the purpose of traction was to think how many square inches of contact surface it had. He found that he could magnetise iron up until it pulled with a force of 175 lbs. to the square inch, and he doubted whether a traction as great as 200 lbs. per square inch could be obtained.

In the following table Joule's results (see Table I.) are recalculated, and the values of B deduced:—

TABLE VII.—Joule's RESULTS RE-CALCULATED.

Description of electro-magnet.		Section.		Load.		Lbs. per sq. in.	Kilos. per sq. cm.	B	Ratio of load to weight.
		sq. in.	sq. cm.	lbs.	kilos.				
Joule's own electro-magnets	No. 1 ...	10	64.5	209.0	947	104.5	7.35	13,600	139
	No. 2 ...	0.196	1.26	49	22	125	8.75	14,700	324
	No. 3 ...	0.0436	6.28	12	5.4	137.5	9.75	15,410	1,286
	No. 4 ...	0.0012	0.0077	0.202	0.09	81	5.7	11,830	2,384
Nesbit's ...	...	4.5	29.1	142.8	647	158.5	11.2	16,550	28
Henry's ...	...	3.94	25.3	750	346	95	6.7	12,820	36
Sturgeon's... ..	...	0.196	1.26	53	22.6	127.5	8.95	14,850	114

I will now return to the data on Table VI., and will ask you to compare the last column with the first. Here are the various values of B, that is to say, the amounts of magnetisation you get into the iron. You cannot conveniently crowd more than 20,000 magnetic lines to the square centimetre of the best iron, and, as a reference to the curves of magnetisation shows, it is not expedient in the practical design of electro-magnets to attempt, except in extraordinary cases, to crowd more than about 16,000 magnetic lines into the square centimetre. The simple reason is this, that if you are working up the magnetic force, say from 0 up to 50, a magnetising force of 50 applied to good wrought iron, will give you only 16,000 lines to the square centimetre, and the permeability by that time has fallen to about 320. If you try to force the magnetisation any further, you find that you have to pay for it so greatly. If you want to force another 1,000 lines through the square centimetre, to go from 16,000 to 17,000, you have to add on an enormous magnetising force; you have to double the whole force from that point to get another 1,000 lines added. Obviously it would be much better to take a larger piece of iron and not to magnetise it too highly—to take a piece a quarter as large again, and to magnetise that less forcibly. It does not therefore pay to go much above 16,000 lines to a square centimetre—that is to say, expressing it in terms of the law of traction, and the lbs. per square inch, it does not pay to design your electro-magnet so that it shall have to carry more than about 150 lbs. to the square inch. This shall be our practical rule: let us at once take an example. If you want to design an electro-magnet to carry a load of one ton, divide the ton, or 2,240 lbs., by 150, and that gives the requisite number of square inches of wrought iron, namely, 14.92, or say 15. Of course, one would work with a horse-shoe shaped magnet, or something equivalent—something with a return circuit—and calculate out the requisite cross-section, so that the total area exposed might be sufficient to carry the given load at 150 lbs. to the square inch. And, as a horse-shoe magnet has two poles, the cross-section of the bar of which it is made must be  $7\frac{1}{2}$  square inches. If of round iron, it must be about  $3\frac{1}{4}$  inches in diameter; if of square iron, it must be  $2\frac{1}{2}$  inch each way.

That settles the size of the iron, but not the length. Now the length of the iron, if one only considers the law of the magnetic circuit, ought to be as short as it can possibly be made. Reflect for what purpose we are designing. The design of an electro-magnet is to be considered, as every design ought to be, with a view to the ultimate purpose to be served by that which you are designing. The present purpose is the actual sticking on of the magnet to a heavy weight, not acting on another magnet at a distance, not pulling at an armature separated from it by a thick layer of air; we are dealing with traction in contact. The question is—how long a piece of iron shall we need to bend over? The answer is—take length enough, and no more than enough, to permit of room for winding on the necessary quantity of wire to carry the current which will give the requisite magnetising power. But this latter we do not yet know; it has to be calculated out by the law of the magnetic circuit. That is to say, we must calculate the magnetic flux, and the magnetic reluctance as best we can; then from these calculate the ampère-turns of current; and from this calculate the needful quantity of copper wire, so arriving finally at the proper length of the iron core. It is obvious the

cross-section being given, and the value of B, being prescribed, that settles the whole number of magnetic lines, N, that will go through the section. It is self-evident that length adds to the magnetic reluctance, and, therefore, the longer the length is, the greater have to be the number of ampère-turns of circulation of the current; while the less the length is, the smaller need be the number of ampère-turns of circulation. Therefore you should design the electro-magnet as stumpy as possible, that is to say, make it a stumpy arch, even as Joule did when he came across the same problem, and arrived, by a sort of scientific instinct, at the right solution. You should have no greater length of iron than is necessary in order to get the windings on. Then you see we cannot absolutely calculate the length of the iron until we have an idea about the winding, and we must settle, therefore, provisionally, about the windings. Take a simple ideal case. Suppose we had an indefinitely long, straight iron rod, and we wound that from end to end with a magnetising coil. How thick a coil, how many ampère-turns of circulation per inch length, will you require in order to magnetise up to any particular degree? It is

a matter of very simple calculation. You can calculate exactly what the magnetic reluctance of an inch length of the core will be. For example, if you are going to magnetise up to 16,000 lines per square centimetre, the permeability will be 320. You can take the area anything you like, and consider the length of one inch; you can therefore calculate the magnetic reluctance per inch of conductor, and then you can at once say how many ampère-turns per inch would be necessary in order to give the desired indication of 16,000 magnetic lines to the square centimetre. And knowing the properties of copper wire, and how it heats up when there is a current; and knowing also how much heat you can get rid of per square inch of surface, it is a very simple matter to calculate what minimum thickness of copper the fire insurance companies would allow you to use. They would not allow you to have too thin a copper wire, because if you provide an insufficient thickness of copper, you still must drive your ampères through it to get a sufficient number of ampère-turns per inch of length; and if you drive those ampères through copper winding of an insufficient thickness the copper wire will over-heat, and your insurance policy will be revoked. You therefore are compelled, by the practical consideration of not over-heating, to provide a certain thickness of copper wire winding. I have made a rough calculation for certain cases, and I find that for such electro-magnets as one may ordinarily deal with, it is not necessary in any case of practical work to use a copper wire winding, the total thickness of which is greater than about half-an-inch; and, as a matter of fact, if you use as much thickness as half-an-inch, you need not then wind the coil all along, for if you will use copper wire winding, no matter what the size, whether thin or thick, so that the

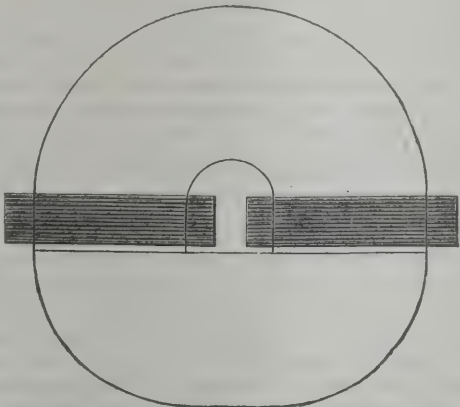


FIG. 23.—STUMPY ELECTRO-MAGNET.

total thickness of copper outside the iron is half-an-inch, you can without over-heating, using good wrought iron, make one inch of winding do for 20 inches length of iron. That is to say, you do not really want more than  $\frac{1}{20}$ th of an inch of thickness of copper outside the iron to magnetise up to the prescribed degree of saturation that indefinitely long piece of which we are thinking, without over-heating the outside surface in such a way as to violate the insurance rules. Take it roughly, if you wind to a

\* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

thickness of half-an-inch, the inch length of copper will magnetise 20 inches length of iron up to the point where  $B$  equals 16,000. If then we have a bar bent into a sort of horse-shoe in order to make it stick on to a perfectly-fitting armature also of equal section and quality, we really do not want more than one inch along the inner curve for every 20 inches of iron. An extremely stumpy magnet, such as I have sketched in Fig. 23, will therefore do if one can only get the iron sufficiently homogeneous throughout. If instead of crowding the wire near the polar parts, we could wind entirely all round the curved part, though the layer of copper winding would be half-an-inch thick inside the arch, it would be much less outside. Such a magnet, provided the armature fitted with perfect accuracy to the polar surfaces, and provided a battery were arranged to send the requisite number of ampères of current through the coils, would pull with a force of one ton, the iron being but  $3\frac{1}{2}$  inches in diameter. For my own part, in this case I should prefer not to use round iron, one of square or rectangular section being more convenient; but the round iron would take less copper in winding, as each turn would be of minimum length if the section were circular.

Now, this sort of calculation requires to be greatly modified directly one begins to deal with any other case. A stumpy short magnetic circuit with great cross-section is clearly the right thing for the greatest traction. You will get the given magnetisation and traction with the least amount of magnetising force when you have the area as great as possible, and the length as small as possible. You will kindly note that I have given you as yet no proofs for the practical rules that I have been using: they must come later. Also I have said nothing about the size of the wire, whether thick or thin. That does not in the least matter; for the ampère-turns of magnetising power can be made up in any desired way. Suppose we want on any magnet one hundred ampère-turns of magnetising power, and we choose to employ a thin wire that will only carry half an ampère, then we must wind 200 turns of that thin wire. Or, suppose we choose to wind it with a thick wire that will carry ten ampères, then we shall want only ten turns of that wire. The same weight of copper, heated up by the corresponding current to an equal degree of temperature, will have equal magnetising power when wound on the same core. But the rules about winding the copper will be considered later.

Now, if you look in the text-books that have been written on magnetism for information about the so-called lifting power or portative force of magnets—in other words, the traction—you will find that from the time of Bernoulli downwards, the law of portative force has claimed the attention of experimenters, who, one after another have tried to give the law of portative force in terms of the weight of the magnets; usually dealing with permanent magnets, not electro-magnets. Bernoulli gave\* a rule something of the following kind, which is commonly known as Häcker's rule—

$$P = a \sqrt[3]{W};$$

where  $w$  is the weight of the magnet,  $P$ , the greatest load it will sustain, and  $a$  a constant depending on the units of weight chosen, on the quality of the steel, and on its goodness of magnetisation. If the weights are in pounds then  $a$  is found, for the best steels, to vary from 18 to 24 in magnets of horse-shoe shape. This expression is equivalent to saying that the power which a magnet can exert—he was dealing with steel magnets; there were no electro-magnets in Bernoulli's time—is equal to some constant multiplied by the three-halft root of the weight of the magnet itself. The rule is accurate only if you are dealing with a number of magnets all of the same geometrical form, all horse-shoes let us say, of the same general shape, made from the same sort of steel, similarly magnetised. In former years I pondered much on Häcker's rule, wondering how on earth the three-halft root of the weight could have anything to do with the magnetic pull; and having cudgelled my brains for a considerable time, I saw that there was really a very simple meaning in it. What I arrived at was this. If you are dealing with a given material, say hard steel, the weight is proportional to the volume, and the cube root of the volume is something proportional to the length, and the square of the cube root forms something proportional to the square of the length, that is to say, to something of the nature of a surface. What surface? Of course the polar surface. This complex rule, when thus analysed, turns out to be merely a mathematician's expression of the fact that the pull for a given material magnetised in a given way is proportional to the area of the polar surface; a law which in its simple form Joule seems to have arrived at naturally, and which in this extraordinarily academic form was arrived at by comparing the weights of magnets with the weight which they would lift. You will find it stated in many books that a good magnet will lift 20 times its own weight. There never was a more fallacious rule written. It is perfectly true that a good steel horse-shoe magnet weighing 1 lb. ought to be able to pull with a pull of 20 lbs. on a properly-shaped armature. But it does not follow that a magnet which weighs 2 lbs. will be able to pull with a force of 40 lbs. It ought not to, because a magnet that weighs 2 lbs. has not poles twice as big if it is the same shape. In order to have poles twice as big you must remember that three-halft root coming in. If you take a magnet that weighs eight times as much, it will have twice the linear dimensions and four times the

surface; and with four times the surface in a magnet of the same form, similarly magnetised, you will have four times the pull. With a magnet eight times as heavy you will have only four times the pull. The pull, when other things are equal, goes by surface, and not by weight, and therefore it is ridiculous to give a rule saying how many times its own weight a magnet will pull. It is also narrated as a very extraordinary thing that Sir Isaac Newton had a magnet, a loadstone, which he wore in a signet ring, which would lift 234 times its own weight. I have had an electro-magnet which would lift 2,500 times its own weight, but then it was a very small one, and did not weigh more than a grain and a-half. When you come to small things, of course the surface is large proportionally to the weight; the smaller you go, the larger becomes that disproportion. This all shows that the old law of traction in that form was practically valueless, and did not guide you to anything at all, whereas the law of traction as stated by Maxwell, and explained further by the law of the magnetic circuit, proves a most useful rule.

From this digression let us return to the law of the magnetic circuit. I gave you in my first lecture, when speaking of permeability, the following rule for calculating the magnetic induction,  $B$ :—Take the pull in lbs., and the area of cross-section in square inches, divide one by the other, and take the square root of the quotient; then multiplying by 1,317 gives  $B$ ; or multiplying by 8,494 gives  $B_{\mu}$ . We have therefore a means of stepping from the pull per square inch to  $B_{\mu}$ , or from  $B_{\mu}$  to the pull per square inch. Now the other rule of the magnetic circuit also enables us to get from the ampère-turns down to  $B_{\mu}$ , for previously we have the following expression for the ampère-turns:—

$$si = N \times \Sigma \frac{l''}{A''\mu} \times 0.3132,$$

and  $N$ , the whole number of magnetic lines in the magnetic circuit is equal to  $B_{\mu}$  multiplied by  $A''$ , or

$$N = B_{\mu} A''.$$

From these we can deduce a simple direct expression, provided we assume the quality of iron as before, and also assume that there is no magnetic leakage, and that the area of cross-section is the same all round the circuit, in the armature as well as in the magnet core. So that  $l''$  is simply the mean total path of the magnetic lines all round the closed magnetic circuit. We may then write

$$si = \frac{B_{\mu} l''}{\mu} \times 0.3132;$$

whence

$$B_{\mu} = \frac{\mu \times si}{l'' \times 0.3132}.$$

But by the law of traction, as stated above,

$$B_{\mu} = 8,494 \sqrt{\frac{P \text{ (lbs.)}}{A \text{ (sq. in.)}}}$$

Equating together these two values of  $B_{\mu}$ , and solving, we get for the requisite number of ampère-turns of circulation of exciting currents:—

$$si = 2,661 + \frac{l''}{\mu} \times \sqrt{\frac{P \text{ (lbs.)}}{A \text{ (sq. in.)}}}$$

This, put into words, amounts to the following rule for calculating the amount of exciting power that is required for an electro-magnet pulling at its armature, in the case where there is a closed magnetic circuit with no leakage of magnetic lines. Take the square root of the pounds per square inch; multiply this by the mean total length (in inches) all round the iron circuit; divide by the permeability (which must be calculated from the pounds per square inch by help of Table VI. and Table II.); and finally multiply by 2,661: the number so obtained will be the number of ampère-turns. One goes at once from the pull per square inch to the number of ampère-turns required to produce that pull in a magnet of given length, and of the prescribed quality. In the case where the pull is specified in kilogrammes, the area of section in square centimetres, and the length in centimetres, the formula becomes

$$si = 3,951. \frac{l}{\mu} \sqrt{\frac{P}{A}}.$$

As an example, take a magnet core of round annealed wrought iron, half-an-inch in diameter, 8 inches long, bent to horse-shoe shape. As an armature, another piece, 4 inches long, bent to meet the former. Let us agree to magnetise the iron up to the pitch of pulling with 112 lbs. to the square inch. Reference to Table VI. shows that  $B_{\mu}$  will be about 90,000, and Table II. shows that in that case  $\mu$  will be about 907. From these data calculate what load the magnet will carry, and how many ampère-turns of circulation of current will be needed.

Ans.—Load (on two poles) = 43.97 lbs.  
Ampère-turns needed = 372.5

N.B.—In this calculation it is assumed that the contact surface between armature and magnet is perfect. It never is; the joint offers additional resistance to the magnetic lines, and there will be some leakage. It will be shown later how to estimate these effects, and to allow for them in the calculations.

Here let me go to a matter which has been one of the paradoxes of the past. In spite of Joule, and of the laws of traction, showing that the pull is proportional to the area, you have this anomaly—that if you take a bar-magnet having flat ended poles, and measure the pull which its pole can exert on a perfectly flat armature, and

\* *Acta Helvetica* III., p. 233, 1758.

† *Philosophical Magazine*, July, 1888.

then deliberately spoil the truth of the contact surface, rounding it off, so making the surface gently convex, the convex pole, which only touches at a portion of its area instead of over the whole, will be found to exert a bigger pull than the perfectly flat one. It has been shown by various experimenters, particularly by Nicklès, that if you want to increase the pull of a magnet with armatures, you may reduce the polar surface. Old steel magnets were frequently purposely made with a rounded contact surface. There are plenty of examples. Suppose you take a straight round core, or one leg of a horse-shoe which answers equally, and take a flat-ended rod of iron of same diameter as an armature; stick it on endwise, and measure the pull when a given amount of ampère-turns of current is circulating round. Then having measured the pull, remove it and file it a little, so as to reduce it at the edges, or actually take a slightly narrower piece of iron, so that it will actually be exerting its power over a smaller area, you will get a greater pull. What is the explanation of this extraordinary fact? A fact it is, and I will show it to you. Here, Fig. 24, is a small

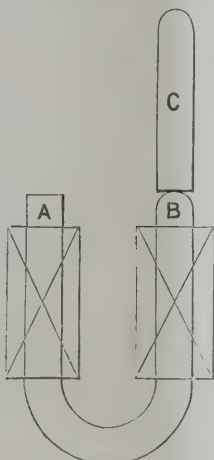


FIG. 24.—EXPERIMENT ON ROUNDING ENDS.

electro-magnet which we can place with its poles upwards. This was very carefully made, the iron poles very nicely faced, and on coming to try them it was found they were nearly equal, but one pole, A, was a little stronger than the other. We have, therefore, rounded the other pole, B, a little, and here I will take a piece of iron, C, which has itself been slightly rounded at one end, though it is flat at the other. I now turn on the current to the electro-magnet, and I take a spring-balance, so that we can measure the pull at either of the two poles. When I put the flat end of C to the flat pole A, so that there is an excellent contact, I find the pull about 2½ lbs. Now try the round end of C on the flat pole, A; the pull is about 3 lbs. The flat end of C on the round pole B is also about 3 lbs. But if now I put together two surfaces that are both rounded, I get almost exactly the same pull as at first with the two flat surfaces. I have made many experiments on this, and so have others. Take the following case:—There is hung up a horse-shoe magnet, one pole being slightly convex and the other absolutely flattened, and there is put at the bottom, on a square bar armature, over which is slipped a hook to which weights can be hung. Which end of the armature do you think will be detached first?

If you were going simply by the square inches, you would say this square end will stick on tighter; it has more gripping surface. But, as a matter of fact, the other sticks tighter. Why? We are dealing here with a magnetic circuit. There is a certain total magnetic reluctance all round it, and the whole number of magnetic lines generated in the circuit depends on two things—on the magnetising force, and on the reluctance all round; and, saving a little leakage, it is the same number of magnetic lines which come through at B as go through at A. But here, owing to the fact that there is at B a better contact at the middle than at the edges of the pole, the lines are crowded into a smaller space, and therefore at that particular place  $B_{\text{middle}}$ , the number of lines per square inch runs up higher, and when you square the larger number, its square becomes still larger in proportion. In comparing the square of smaller  $B_{\text{middle}}$  with the square of greater  $B_{\text{edge}}$ , the square of the smaller  $B_{\text{middle}}$  over the larger area turns out to be less than the square of the larger  $B_{\text{edge}}$ , integrated over the smaller area. It is the law of the square coming in.

As an example, take the case of a magnet pole formed on the end of a piece of round iron 1.15 inch in diameter. The flat pole will have 1.05 inches area. Suppose the magnetising forces are such as to make  $B_{\text{middle}} = 90,300$ , then, by Table VI., the whole pull will be 118.75 lbs., and the actual number of lines through the contact surface will be  $N = 948,150$ . Now suppose the pole be reduced by rounding off the edge till the effective contact area is reduced to 0.9 square inches. If all these lines were crowded through that area, that would give a rate of 105,630 per square inch. Suppose, however, that the additional reluctance and the leakage reduced the number by 2 per cent., there would still be 103,500 per square inch. Reference to Table VI. shows that this gives a pull of 147.7 lbs. per square inch, which multiplied by the reduced area 0.9 gives a total pull of 132.9 lbs., which is larger than the original pull.

(To be continued.)

## SOME GENERAL REMARKS ON TELEPHONE EXCHANGE CONSTRUCTION AND EQUIPMENT.\*

By F. A. PICKERNELL.

THE modern telephone exchange building should be thoroughly fire-proof. False floors and concealed masses of wires should be avoided, for a fire once started in such places is extinguished with great difficulty. In its erection, everything should be sacrificed that in any way interferes with the particular object for which it is built. In the basement racks are to be provided for underground cables. Between the basement and the terminal room a cable shaft or system of ducts is to be constructed. On the top floor are to be located the operating, terminal, battery and power, cloak and lunch rooms. These rooms should be provided with chemical fire extinguishers, and the manager, fire chief, and his assistants thoroughly instructed in their use.

In case of fire every effort should be made to suppress it without calling on the fire department. If the fire should attain considerable proportions, it could at its worst only consume all the combustible matter in the room, for inasmuch as the operating room is on the top floor, the fire could not cripple any of the supporting columns or beams of the building and cause it to fall. If a small fire was started and the average fireman admitted, he would do more damage with his axe and hose than the fire would in entirely consuming the apparatus.

Before a telephone company is in a position to erect a suitable building it is necessary to make definite estimates of the probable extent of the underground work, the ultimate number of subscribers it will be desired to handle at the proposed exchange, the probable number of trunks to other exchanges, the probable number of extra territorial lines, the amount of private wire business, the probable average number of calls per subscriber per day, when the switchboard attains its ultimate capacity. A careful estimate of this kind determines the ultimate capacity of the switchboards, underground cable runs, &c., and consequently fixes the minimum size of the building.

In order that the building may fulfil the requirements of a modern telephone exchange, a technical expert should be provided with these estimates, and his opinion taken before any land is purchased or building erected. He should collaborate with the architect in making the building plans. Mistakes have already been made by telephone companies in adopting plans of good office buildings, and afterwards placing the switchboard wherever room could be found. Such buildings have been found unsuitable for modern telephone exchanges. It does not follow from this that the requirements of a good telephone building are necessarily incompatible with the demands of an office building.

One of the first matters to be considered in planning the building is the handling of the underground cables. The system for bringing in the cables should be thoroughly flexible, and permit of the drawing in and out of any particular cable when the point of ultimate equipment is reached. The cables are to be extended through the basement to vertical rows of ducts, or to a suitable cable shaft, extending to the cable terminal room. The massing of the cables in rows of ducts extending to a large number should be avoided. Wherever it is necessary to pass from one system of ducts to another system, the cable should be brought into a vertical row, thus rendering each cable accessible. Before any building plan is adopted, a complete working plan for the handling of the underground cables should be made. This working plan should show the exact location of every cable in the subway at each turn and the location of its inside terminal.

It is preferable to head up cables in a terminal containing a sneak current and lightning arrester. The sneak current arrester should operate with the current of three-tenths of an ampere in 40 seconds, and the lightning arrester should operate when the potential of the wire rises to 300 volts. By using a combined cable head and strong current arrester, economy and space as well as inexpensiveness are insured. The strong current arrester should be so designed that the lines can be tested at this point, by using suitable plugs. The terminal room should also contain a distributing board and chief inspector's desk. The most economical, compact and flexible distributing board that has yet been devised is that known as the "Hibbard iron distributing board." The cable terminals should be connected with the line side of the distributing board by flexible cable, all connections being solid. The switchboard cables terminate on its other side. For cross connecting wires, okonite wire No. 20 B. and S. gauge, insulated to  $\frac{3}{32}$  of an inch, twisted in pairs, should be used, all connections being solid.

The chief inspector's desk should be located immediately in front of the distributing board and should be provided with a telephone outfit, Morse key and relay, Wheatstone bridge and galvanometer and loops extending to the tower and battery room, local switchboard and chief operator's desk. It should be provided with testing plugs for use at the strong current arrester.

Near the terminal room should be located a power and battery room, and in this room battery racks should be provided upon which operators' transmitter batteries and chief inspector's testing batteries can be located. The battery rack should be wired with waterproof wire in a permanent manner. In this room a gene-

\* Read at the National Telephone Exchange Association, Detroit, September, 1890.

rator switchboard should be provided, and have terminating upon it loops to the various portions of the multiple board and also the terminals of all generators. Electric motors, water motors, or other suitable power supply, should be located here. Both the terminal room and battery and power room should be so located that it will be possible to enter them without passing through the operating room.

On the same floor and adjacent to the terminal room should be located the operating room. This room should be large and well ventilated, free from elevator shafts, columns or other obstructions. The switchboard should commence at the end of the operating room nearest the terminal room, and extend from it in a straight line. If it becomes necessary to deflect the switchboard from a straight line, it should be arranged so that the operators sit on the inside of the curve. This enables the chief operator's desk to be so located that all parts of the switchboard are visible from this point. The size of the room necessary will depend upon the ultimate capacity of the switchboard.

If the switchboard is to have an ultimate capacity of 4,000 lines or over the extra territorial trunk section should be the first in the system. It should be equipped with five-point spring jacks and three-point plugs, so that when a line is in use at the trunk section it tests busy at the other boards.

If a switchboard is to have a capacity of less than 4,000 lines, the trunk-board should be made the last section in the system, and the regular Chicago spring jack used. The reason for locating it last in the system is as follows:—Whenever a metallic circuit connection is made at any section, an open leg is attached, which extends throughout the rest of the board, to the answering jack, the open leg being shortest on connections made at the last section. In large boards, this introduces an appreciable amount of cross-talk. By making the trunk line section the last section in the board, all connections made at this board have a minimum length of open leg, and consequently the switchboard cross-talk is reduced to a minimum. The answering jack should be the last spring jack in the system, thus ensuring in every connection at least one of the parties connected having no open leg attached to his circuit. If the answering jack were the first spring jack in the section, every connection would have at least one open leg attached to it extending throughout the whole system.

Next to the trunk section comes the regular multiple board, the number of sections depending upon its present equipment. It has been found that the sections of multiple board six panels wide, of the hog-trough type, and having an ultimate capacity of 300 subscribers' drops, is the most desirable form of multiple switchboard. On the back of the hog-trough is to be located tubular clearing-out drops and tubular subscribers' drops. Immediately back of the hog-trough is to be located a cord shelf upon which both cords are to be placed. In the face of the board, immediately above the cord shelf, is to be placed the answering jacks; above the answering jacks, the subscribers' jacks.

The standard condenser listening and long-distance ringing keys with talking contacts of platinum have been found to give most excellent service. On the framework immediately under and back of the cord shelf is to be located an intermediate distributing board. It has been found that it is possible to so distribute the busy subscribers with those that are not so busy, as to make approximately equal the work for all the operators. In order to do this, without changing the number of the subscriber, the intermediate distributing board has been designed. One side of this board is connected to the answering jack and subscribers' drop, and the other side to the cables coming from the multiple board. By placing two numbers on the subscribers' drop, one on the shutter corresponding with the answering jack, and one on the face-plate corresponding with the spring jack number in the multiple board, it is possible to make cross connections at the intermediate distributing board and not change the drop number of the subscriber.

A change of this kind will be effected as follows: Suppose that the operator upon which subscriber No. 654 terminates was very busy, and that the operator upon which subscriber No. 235 terminates was not so busy; and also that the subscriber No. 654 was a very busy wire, and subscriber No. 235 was not a busy wire, it would be desirable to interchange the answering jacks of these two subscribers, for by so doing the work of the operators would be more equally divided. This would be done at the intermediate distributing board by cross-connecting the two answering jacks and by changing the face plates on these two subscribers' drops. The office record of circuits should be so constituted as to admit of this dual numbering of drops.

The double track system for intercommunication between offices is recommended. Push buttons connecting local operators with the talking circuits are to be placed within easy reach in front of each operator. All in-coming trunks should terminate on single cords, and be operated by a call wire system. For this purpose the incoming trunk line operator has his head telephone included in the talking circuit from the other exchanges. The trunk circuits should be arranged so that if the calling wire breaks down, any other trunk line may be quickly substituted, and pending the change, the trunk lines operated by drops. It is also desirable to have the circuits so constructed that when the operator at the originating office disconnects a trunk line, the operator at the receiving office is notified automatically by special signal. This reduces the number of calls on the talking circuit one-half.

In front of the switchboard, in such a position that all sections may be easily seen, a monitor desk should be placed. This desk should have, terminating on spring jacks, loops extending to each operator, to the chief inspector's desk and to circuits in the mul-

tipale board. All operating rooms should be carpeted with linoleum to prevent noise by people walking about. On the same floor as the operating room a cloak room and lunch room should be provided. The lunch room should be equipped with tea and coffee urns, lunch table, &c. By providing such conveniences for the operators a better class of women become available and exchange service correspondingly improved.

In closing these remarks I would call attention to the necessity of providing complete working plans and specifications of the proposed equipment, including the cable run, before the construction of the building is commenced. Extensive alterations in buildings and apparatus already made in several of our central offices would not have been necessary had this been done. Such plans are as necessary to the successful and economical erection of a modern telephone exchange as are the plans for the erection of a suspension bridge or other engineering work.

In the discussion which followed the reading of the paper, Mr. CARTY, gave his views briefly on the subject of "Bridging Bells" This is a system of looping, the idea being if you had more than one station on a line to loop the intermediate stations in solid. It was found that a magnet in a line had something in it besides the mere resistance to the copper. The fact that your wire is coiled around on a core offers a resistance to the telephone current a great deal more than that represented by the number of ohms of wire. In nearly all of the lines that are constructed with more than one station looped down, the talking is very poor. A line was built in New York containing eight miles of underground cable and four miles of overhead wire and 10 stations looped in solid, and it was impossible to talk over it. The bridging bells were put on that line, and the talking over it now is as near perfect as it could be. It is impossible to tell the difference between a line having 10 stations on it and a line with only two stations. Mr. Sabin, of San Francisco, procured eight of the bells and put them on a line running from San Jose to San Francisco. The line had eight stations looped in, and it had been impossible to use it for through business at all, and talking to the way stations was very poor. But having equipped the line with these bells, he reports that it is impossible to tell the difference between talking on the way line and talking on the through line, and says that the induction on the way line bridged in this way is less than it is on the through line. So that actually it has turned out that the line works better with eight stations on it than it did with only two. This line is of iron, and is a grounded circuit, and these bells are simply bridged in or legged on. When lines are constructed on the bridge or multiple arc system, the construction of the wire is made much simpler. There is no bottom contact on it, and the bell rings equally well, whether the telephone is on the hook or off. In looking at some railroad troubles in Albany, I found that the drops were down and the business was paralysed. Mr. Pickernell made a suggestion that I take up some double-wound resistance coils and put them in between the drop and the ground. I did so, and that was a perfect remedy, and we ordered 50 of them and fixed it. While there it occurred to me that a bridging bell would act even better. I sent one up and it freed that line from the drop trouble. The particular bell that has been designed for this work has had introduced into it some mechanical improvements that are also applicable to the series bell. We have nut-lock binding posts, and wherever a wire was fastened by a tip these posts were put on and the wire was soldered. The lightning arrester was also taken off, because you might as well paint one on there as to use the present one. The lightning arrester forms a point generally where a fire starts. That bell was prepared with that in view, and if lightning protection is wanted it should be provided by the most approved plan and forming a part of the general scheme of protection against any currents. I think that is briefly all there is to it. In substance, it is, that if anybody here has a line with a lot of stations on it that is not working well, if he orders some of those bells they will make it work well. The Boston people have used some of the bells, and have constructed a fifteen station line for the Armstrong Transfer Company, and they reported to me that, taking the old line at one the working of the new line might be placed at 300. The working of this system in New York has been very gratifying. We started with the New York Central Railroad and reconstructed their ticket line and equipped it with bridging bells: Then the freight people heard about it, and now the result is that we have 40 stations on three lines for that company.

A MEMBER: Are those metallic or grounded?

MR. CARTY: Those are metallic. This practice is quite different from the ordinary looping practice. For instance, in the American Express Company—who made a big contract with us to equip them in the same way—they moved one of their stations, and we sent one of our men up and he took out the telephone, and, as had been his custom, he twisted the two ends of the wires together. That was a correct thing for him to do, as far as he knew. But it had the result, as you see here (illustrating on diagram) of just throwing the whole line out by short-circuiting it. Another man, in putting in a bridging station, drove a tack which crossed two wires together, and that prevented its bell from ringing. He started round looking for an opening, whereas he should have looked for a short circuit. So that this practice is diametrically opposed to what he had been used to. The question of an individual bell should not be confounded with this. The first thing is to get a line over which he can talk. After this is done, then that old saw of individual bells might come up again. You provide signals, and all of the stations are signalled when anybody rings. The construction of that bell is very little different from some

other bells that are made to do the work, but when you come to use 10 or 15 stations on a line you have got to have exactly that construction, and it is such an important matter to the licensees that we are making great efforts to get a patent on it. In designing that we not only have an idea of our immediate wants, but we wanted to get a bell that we could say would work on any line. Take a line with 20 stations. They are building a line now 40 miles long, of copper wire, and to be equipped with 20 stations.

Mr. GIFFORD: It would be very easy to arrange that, just as the district messenger people do with their calls coming in.

Mr. BAILEY: I want to say with reference to that system, that while the idea of telephone service is supposed to be the supplying of subscribers with an individual or single circuit, that is, a circuit on which but one telephone is placed, yet the conditions are such in a great many parts of the country, and particularly with corporations, that you cannot persuade them that it is the kind of service they want. These corporations are those that have been accustomed to telegraph systems, and they imagine that when they have a system which they can reach individually, without the intervention of a central office, that they are getting very much better service. It doesn't matter what our opinion is about that, when you try to bring those people to your way of thinking, you will find it very much of an uphill job, and the next thing to do is to accept the conditions and accommodate them. That can be done by a system of that kind. There is another advantage in that system which I think will be available in the future, and that is in the way of giving cheaper telephone service on metallic circuit lines to residences. The chief difficulty that I see about that system is on long extended lines, the liability that you have of damage to the apparatus by lightning. Our company have had for a number of years a system similar to that in operation on quite a number of lines. We have arrived at it by running a shunt wire, commencing at the first station out from the exchange. This shunt wire is passed in through the station, and the calling wire is looped through. The operation of that is, when a call has been made, the removal of the telephone opens the caller's circuit and lets the talking circuit from the earth through the shunt wire, thereby giving a free and independent wire for conversation. The talking over those lines has been magnificent. We get rid of the resistance of the coil through the circuit. I wanted to ask Mr. Carty if he found any of the effects of those coils reached the earth, as against the talking circuits. In the operation of those lines of ours we have found that in a thunderstorm the usual accidents we had were from lifting the switch and turning out the induction coils or the transmitters. That we obviated by putting a bridge there which shoves the switch to the earth, so that the current more readily passes through this direct wire than through the induction coil. I do not know whether, in this system, the ringer coils would not be subject to destruction. I think possibly there would be considerable trouble in that respect. However, it may be met by introducing some device. I should say that high resistance coils are more susceptible to damage by lightning, and when you take a line of that kind working in the country, it means stations far away and hard to reach, and therefore expensive, and a long interruption to service.

Mr. GIFFORD: That is a kind of business that it is not desirable to take.

Mr. BAILEY: But it is a kind of business you are obliged to take.

Mr. GIFFORD: I try to dodge all of that kind of business that I can.

Mr. BAILEY: But I should say, in Mr. Wilson's case in Chicago, he will find service of that kind that he cannot ignore. You must accept the situation, and devise something that will meet the demand.

Mr. GIFFORD: I do not wish to be considered as throwing any cold water on this system. I hope they will perfect their bridge bell and get a patent on it, but I do not see how it will work in all localities. Perhaps in some localities it will do. I would not know what to do with it—for instance, if I tried to use it for residence service. We make a cheap rate—all our rates are cheap (laughter); we make a cheaper rate to get some residences. You see, in Louisville, the residences are over on one side of the town, and the business portion of the city is on the other, and we debated whether we should cultivate that trade or not. At last we made a cheap residence rate, two and three subscribers on a line. Now, the Louisville woman don't want any other woman listening on her line, and they raised so much of a row that we had to do away with it.

Mr. BAILEY: Then you have had the advantage of educating those people to something better?

Mr. WILSON: Reference has been made to this question in Chicago. At one time we had quite a number of very long private lines, and the stations having been added one at a time that condition of things was permitted to go on until we found that we had a good deal of very unsatisfactory private line service. About a year ago we established a rule that we would not take any more private lines with more than five stations upon them, and we have succeeded in getting our private line business on that basis, and where a larger number of stations was required we have put in what we call our branch exchange service. For instance, the West Side Street Railroad Company have a private line of that description. They have their own exchange and their own operators. It costs them more money than it would to have a line run into our exchange at \$125 a year each, although we give them a reduction in the rate. The expense of operators to them makes it a little more than they would have to pay us. In that way we have entirely eliminated the long line private wire diffi-

culty. Now, the only objection that I see to the bridging arrangement on grounded circuits is the difficulty in locating troubles on the lines. We have been bridging our clearing-out office in Chicago for about two years, and find a great improvement. We have some very long underground lines, through cable, which were laid in the early history of the underground business, and with no margin for conversation at all. When we came to inserting the clearing-out drop in the old way it made conversation entirely impossible. After we re-wound our clearing-out branches with 300 to 500 ohms it brought the talk right up. So that I am well satisfied that the bridging scheme is the proper thing. But if you can avoid the bridging scheme and have independent lines, it is still better.

Mr. HIBBARD: This bridging-in question is a very important one. In Buffalo we have been doing a good deal of metallic circuit work for the last two years, and we had a good many combination lines, or party lines, which, after the electric lights were in operation, gave very poor service. We commenced this system of bridging-in with one or two more subscribers on a line, using first the ordinary bell, which gave us of course very poor service. Then we put in 500-ohm ringing coils. With that system and with 500 ohms in the central office, we are getting first class service with five and six on the line. We have also quite a number of private lines used by railway companies, where they have as many as eight and nine stations on the line, bridged in with 500-ohm bells, and those stations are giving splendid service.

Mr. WILSON stated that they were operating all the transmitters in the main office of the Chicago exchange with the Edison current, and are accomplishing good results. We use storage batteries. We are using at present five cells of storage batteries, which have an electromotive force of a little over two volts per cell and gives out about five amperes of current. The five cells are connected directly with the Edison current which supplies the office with light, and the storage takes place when we burn the light and we do not observe any diminution in the lighting throughout the building. There is, therefore, no expense for current. The internal resistance of each cell of the storage battery is about two-hundredths of an ohm. Consequently, as you add transmitters, it simply absorbs more current than the storage battery. The object of having five cells is that it enables us to maintain the storage battery throughout the 24 hours without its becoming exhausted. If we connected all the transmitters we would necessarily have to turn on light during the day to recharge them. Our experience has shown that with five cells it works entirely automatically. We supply between 60 and 70 transmitters.

Mr. GIFFORD: How many transmitters will one cell energise during 24 hours?

Mr. WILSON: The arrangement we have contemplates 100 transmitters. We are only operating 60.

Mr. BAILEY: How many transmitters do you couple on to one cell?

Mr. WILSON: At the present time it is about 12, and we adjust the resistance until the current in each transmitter is all that it will stand. We use the Edison current for ringing instead of the small generators.

## NEW PATENTS—1890.

14927. "Improvements in telephones." G. MACAULAY-CRUIKSHANK. (Communicated by E. B. Welch, United States.) Dated September 22. (Complete.)

14974. "Improvements in electric meters." W. T. GOOLDEN and S. EVERSHED. Dated September 22.

15043. "Improvements in electric heating apparatus." W. R. LAKE. (Communicated by E. Abshagen, United States.) Dated September 23. (Complete.)

15061. "Improvements in electrical apparatus for the prevention of corrosion, and formation of scale in steam boilers." J. TELLEFSEN. Dated September 23.

15084. "Improvements in electric railway conduits with tubular conductors." C. J. VAN DEPOELE. Dated September 24. (Complete.) [Date applied for under Patents Act, 1883, Sec. 103, 22nd May, 1890, being date of application in United States.]

15114. "Improvements in the manufacture of plates for secondary batteries, and in the construction of such batteries." G. C. FRICKER and J. R. BAINTON. Dated September 24.

15165. "Conveying additional telegraph or telephone wires over houses and other different places after one wire or cord has already been stretched." W. J. PARKER. Dated September 25.

15191. "Improved process or method of renewing flexible carbon filaments in glow or incandescent electric lamps." C. PAUTHONIER and L'INCANDESCENCE ELECTRIQUE SOCIETE. Dated September 25.

15203. "An improved socket for incandescent electric lamps." H. H. LAKE. (Communicated by J. S. Potter, United States.) Dated September 25.

15221. "Improvements in the production of electric currents by means of air or water for lighting steamships and railway trains, and for other purposes." P. R. DE F. D'HUMY. Dated September 26.

15248. "Improvements in dynamos and electric apparatus for charging accumulator cells and running lamps at the same time."

W. B. SISLING, W. H. SCOTT, and LAURENCE, SCOTT & Co., LIMITED. Dated September 26.

15249. "Improvements in the manufacture of electrical conductors." A. MUIRHEAD. Dated September 26.

15250. "Improvements in and relating to the electric circuit connections used for lighting theatres and for analogous purposes." H. SOUTH. Dated September 26.

15251. "An improved supporting base for electric lamps and conduit for conductors therefor." H. SOUTH. Dated September 26.

15252. "An improved holder for incandescent electric lamps." H. SOUTH. Dated September 26.

15274. "A method of, and appliances for automatically utilizing any excess of electricity generated for electric lighting and other purposes, and for automatically supplying any deficiency." E. B. BRIGHT and F. W. ENGELBACH. Dated September 26.

15328. "Method and devices for heating by means of electric currents." C. ZIPERNOWSKY. Dated September 27.

15337. "Improvements in or relating to electric alarm bells." J. B. M. BONNARDOT. Dated September 27.

### ABSTRACTS

#### OF PUBLISHED SPECIFICATIONS, 1889.

7165. "Apparatus for electrical distribution of energy." J. M. MUNRO. Dated April 30. 8d. Relates to the use of high tension continuous currents or varying strength with transformers in series or parallel. 2 claims.

8493. "Improvements in automatic cut-outs for electrical circuits." W. J. STARKEY BARBER-STARKEY. Dated May 22. 8d. The inventor includes a small dynamo or magneto-electric motor in a high resistance shunt from the dynamo or mains. By means of stops or other devices he limits the possible angular motion of the armature of this electro-motor, so that it may not rotate continuously whilst its circuit is closed. The spindle of the armature is geared or connected with a switch or device such as a mercury or brush contact, for opening and closing the main circuit. If it is required that the apparatus shall close a circuit as soon as the pressure reaches a certain amount, the force which opposes the rotation of the armature is regulated so that the armature can move only when that pressure is reached. If it is desired that the circuit should be opened as soon as the current reaches a predetermined pressure, the force opposing the rotation of the armature is regulated so that the armature will not move until that pressure is reached; in this case the main circuit is already closed, and the apparatus operates to open it; in the former case the reverse happens, that is to say, the circuit is already open, and the apparatus closes it. When the armature of the motor moves in consequence of the pressure having reached a determined amount, the motion of the armature is communicated by the connecting device to the switch or contacts, so as to open or close the circuit as hereinbefore described. When it is desired to open the circuit, if more than a determined pressure exists in the main, the motor may have one or more coils of thick wire included in the main circuit. 7 claims.

8780. "Improvements in electrical switches or cut-outs." E. E. DE FACIEU. Dated May 27. 8d. Consists essentially of a contact piece, which once set to the position of "closed circuit," is held down in that position by magnetic attraction, which magnetic attraction ceases as soon as the current conveyed by the switch increases by a definite quantity or percentage; the contact piece being then released, automatically reverts to the position of "open circuit," and stops the current. 2 claims.

8815. "Improvements and devices for automatically interrupting an electric circuit under predetermined conditions." W. P. THOMPSON. (A communication from abroad by the Westinghouse Electric Company, of America.) Dated May 28. 8d. Is designed to provide a circuit-controlling device which shall insure that the circuit leading to the filaments shall be interrupted, and the treatment thereof terminate when the resistance of the filament has decreased to a certain predetermined point. 3 claims.

12970. "Improvements in printing telegraph instruments." J. E. WRIGHT and J. MOORE. Dated August 16. 11d. According to this invention the type wheel is turned in both directions, so that it never has to perform more than a half revolution, and it is brought back to zero after every printing operation. 6 claims.

13675. "Improvements in the arrangements and apparatus for electrically lighting railway trains." W. E. LANGDON. Dated August 30. 8d. Relates to the employment of an improved electrical coupling for connecting the several cables or wires through from vehicle to vehicle, and for automatically, under certain conditions, connecting together and disconnecting certain of the said cables or wires. And in the employment in connection with certain of the said cables in each vehicle electrically lighted, where the system of electric lighting is that known as the "parallel" system, of an electrical resistance automatically operated so that when the current from the dynamo is in operation, the said resistance shall be thrown into the lighting circuit of the said vehicle, and when the current from the dynamo is not in operation, the

said resistance shall be cut out of the lighting circuit. Also in the employment upon any electrically lighted vehicle, of a special device for the purpose of enabling the electrical condition of the batteries or accumulators of the said vehicle to be readily ascertained, and for providing against injury to the batteries by "short circuiting" at such points. Also in making suitable provision for obtaining ready access to the electric lamps for cleaning and for other purposes. 8 claims.

### IDENTITY OF STRUCTURE BETWEEN LIGHTNING AND THE DISCHARGES OF INDUCTION MACHINES.

DURING the storm which burst over Meudon on May 8th, 1890, at about half-past six in the evening, the flashes of lightning, which were frequent and very high, took in nearly every case a horizontal direction; later on, when the rain had commenced, they were vertical, darting from the cloud to the horizon. The horizontal flashes were distinguished by a well-defined arborescent form, the numerous ramifications of which were lost in the cloud. For the most part they appeared singly, but between 6.50 and 7.10 in several instances two were seen at once, coming to meet one another from opposite directions.

One of these pairs of flashes, which subtended an angle of more than 90°, appeared in front of me, under conditions peculiarly favourable for observation. They appeared simultaneously; two separate points of the cloud were lighted up at the same instant, and two dazzling masses of light darted towards each other dividing into several branches, which in their turn were subdivided into smaller ones. The meeting, which seemed inevitable, did not, however, take place; although the extremities of the opposite branches were only separated by a space of less than 10°.

These flashes, writes M. E. Trouvelot to the *Academie des Sciences*, which lasted long enough to enable one to see clearly the form they took, were a revelation to me. It was no longer two flashes of lightning that I saw, but two electric sparks, absolutely similar, except as regards their magnitude, to the sparks of induction machines, which have become so familiar to me by long study, that I can recognise their characteristics at a glance.

In these arborescent forms, I noted that the one which came from the north, against the wind, and the branches of which were sinuous and undulating, had the appearance that is characteristic of the discharges of the positive pole of induction machines, whereas the one that came from the south, in the direction of the wind, and the zigzag branches of which deviated abruptly at right angles, had the appearance that characterises the discharges of the negative pole.

My observations seem to me conclusive; they show that in certain storms, which I will term *dry storms*, the electric discharges termed *lightning* act almost like those of our machines on bodies that are only slightly conductive, and have almost the same structure. If even there were any doubt about the characteristic forms which I observed, the very fact that two branched flashes advance towards one another and almost meet, is sufficient to prove that the sources of electricity which provoked them must be of contrary natures.

On the occasion in question, I could only observe very imperfectly, on account of its great distance, the flash uniting one cloud to another, or to the earth, by a line of fire. However, judging by analogy, and what I have observed since, and also by the examination of several photographs of flashes of lightning, there seems to be no doubt that this kind of lightning corresponds to the discharges of the opposite poles of machines, when they are united by a powerful spark.

From these observations it follows: 1st, that the arborescent flash electrifies the cloud by discharging itself upon it, as the discharges of machines electrify the sensitive plate; 2nd, that it can go down or up, horizontally or obliquely, in short, that it may take any direction; 3rd, that it varies in form according as the

storm is dry or accompanied by rain, and is more complicated in the first case. Lastly, the arborescent and complicated form of the flash not appearing on one plane, but at variable distances, explains the characteristic noise of thunder.\*

### A NEW SAFETY LAMP FOR MINES.

Note by M. CHARLES POLLÁK.

(SUBMITTED TO THE FIRE DAMP COMMITTEE.)

THE following is a brief description of this lamp :—

A rectangular box of ebonite contains some accumulators of the Pollak type;† this box rests on a metal tray. An ebonite lid serves as a support for an incandescence lamp, which is enclosed in a cylinder of thick glass. The whole is covered with a metal cap, fastened by means of bolts. A sheet of soft gutta-percha, interposed between the lid and the box, closes it hermetically. Rods of inoxidisable metal are inserted in the lid, passing right through it; at their bases are platinum contacts which rest upon platinum contacts in the accumulators, and at their other extremities are springs, one of which is connected metallically with one foot of the lamp. The other foot is insulated, and can be brought into contact with one pole of the accumulator by means of a needle which is introduced into a horizontal groove in the lid.

The contacts being on the inside of the box and the lid, neither the opening nor the closing of the circuit can cause any explosion. Thus the lamp may be lighted or extinguished in an inflammable atmosphere. If the system is thrown out of working order, or if the protecting glass cylinder is broken, the lamp is extinguished.

The lamp is charged, without being taken to pieces, by means of a fork, which is introduced into two grooves hollowed out in the lid.

The model in existence weighs about 1,800 gr., and gives, on an average, 12 hours of perfectly constant light, the power of which = .7 to .8 of a candle-power. —*Comptes Rendus.*

### CORRESPONDENCE.

#### Electrical Heterodoxy.

I am glad Mr. Sutton has come to the conclusion that a continuance of this correspondence would be a waste of your valuable space. Other duties occupy all my present time, but if spared I intend writing an article which shall be headed *What is Induction?* And in it this whole subject shall be embraced. In the mean time, I ask Mr. Sutton to bear in mind that when Faraday abandoned the theory of action at a distance he saw the necessity of devising something as being the cause of the various phenomena to which he gave the name of *induction*. For this purpose he invented the idea of two electric forces. To the action of these two forces he attributed all the effects which he called *induction*. Whereas in Mr. Sutton's first letter he gave a diagram and explanation of it, which showed that he believed in that which Faraday called induction, and yet Mr. Sutton maintained that there was no need to believe in Faraday's two forces. If Mr. Sutton had proceeded to state something as a substitute for

\* Photographs of direct discharges of electricity from the cloud to the sensitive plate might prove of great service in the study of lightning. We have already made some attempts in this direction, but unsuccessfully, with a captive balloon which had been kindly placed at our disposal by Commandant Renard, whom we take this opportunity of thanking. Experiments of this nature would no doubt have greater chances of success, if they were made at elevated parts of the globe.

† Presented to the Academy, March 17th, 1890.

Faraday's two forces all might have been well, but he did not do so, and therefore left others to conclude that he believed that an effect might be produced without a cause.

This is only one of the fundamental errors about electricity contained in Mr. Sutton's first letter which, if I had answered fully, would have led to a lengthened correspondence, which would have occupied uselessly much of your valuable space. If Mr. Sutton will not read in private a book that will give him much-needed information about electricity, he cannot expect that his lucubrations about electricity will be answered in the public prints.

Mr. Sutton is wrong in his surmise about the insulated gas-flame test. In your leading article you expressed no doubt of the accuracy of this test, and all the various parties who have seen my experiments with it from the year 1839 till now have been convinced that I am right.

Pith balls and similar substances, when placed between two bodies between which a current of electricity is passing, always oscillate between the two bodies, and therefore pith balls give no indication of the direction in which the current of electricity is moving; but an insulated gas flame never oscillates—it always bends steadily in the direction in which a current of electricity is moving, and hence its value as a test.

James Johnstone.

13th October, 1890.

#### Mutual Telephone Company and Yorkshire Telephone Company.

Can you kindly inform me through your next issue how far the above companies are developed, and whether they have commenced actual work yet? Also, whether any other companies are applying for licenses?

Telephone.

October 13th, 1890.

#### The National Telephone Company and Muirhead, Glasgow.

In your last week's issue you refer at length to a letter of mine that appeared in the *North British Daily Mail*, Glasgow. My letter referred to several points, but I shall first refer to the one which you are sceptical of, as you do not think that the National Telephone Company could be guilty of such an act of tyranny as I impeach them with. I enclose herewith six original letters from the National Telephone Company, addressed to myself. In justice to me you will, I am sure, publish them, as they bear out my statement that the National Telephone Company's vice-chairman, Col. Jackson, and the chairman of the Glasgow Board, invited me to bring from France a number of Ader and Berthon Telephones, which they kept in their possession for about two months, then ordered me, on pain of an action at law, to return them. This I declined to do, but offered to send them to the Glasgow office; but as they did not at first accept this offer, I withdrew that also.

They then, in defiance of the clearest evidence, denied I had ever signed a contract for the use of their exchange telephone, which they removed without the usual six months' notice, though their own directory and other printed rules says, "every subscriber must sign a contract," &c.

They get their subscribers to sign contracts which they themselves keep, so that they can blow hot and cold with the same breath.

They have neither the courage to deny those statements I have publicly made nor the manliness to own themselves wrong.

The proposed demonstration will be with an *Ader receiver* and a *Gower receiver*, used as a transmitter, both of which I believe are free on 9th December. With this Ader receiver you can hear though some

yards from it, when speech is transmitted by a Berthon transmitter.

A. Erskine Muirhead.

14th October, 1890.

The National Telephone Company, Limited.  
Glasgow Offices, Royal Exchange Buildings,  
13th March, 1890.

A. E. Muirhead, Esq.

Dear Sir,—Referring to your interview with Col. Jackson and myself this morning, I shall be pleased if you will send on to London two Ader receivers, No. 3 in your catalogue, and four of the same, here, and two of the Poste Berthon transmitters, No. 117 in your catalogue, to London, and four of the same here.

The above to be sent on loan for trial here and in London.—

Yours truly, WM. ALEX. SMITH,  
Chairman of Glasgow Board.

The National Telephone Company, Limited,  
Glasgow Offices, Royal Exchange Buildings,  
9th June, 1890.

A. E. Muirhead, Esq., Cart Forge, Crossmyloof.

Dear Sir,—I am much obliged to you for the loan of the French instruments, which I now return. Please receive herewith three Ader receivers, two Ader transmitters, two Berthon transmitters and one Berthon-Ader combined with magneto.—Yours truly,  
W. AITKEN, Engineer.

The National Telephone Company, Limited,  
Oxford Court, Cannon Street, London, E.C.,  
25th June, 1890.

A. E. Muirhead, Esq., Glasgow.

Dear Sir,—We are in receipt of your letter of 24th and also of "Gower" instrument. This instrument is a distinct infringement of our patent rights, and by importing it you have rendered yourself liable to proceedings for an injunction and for damages. As you have sent the instrument evidently in good faith we return it to you, but at the same time we must insist on your returning it and any other similar instruments to France forthwith, or we shall have to institute proceedings against you, and we shall require a declaration from you that this has been done.

As I mentioned to you in mine of 11th inst., we cannot see our way to accepting your proposal as to royalties. I must also inform you that we do not sell any instruments.—Yours faithfully,

T. BLAICKIE, Secretary.

The National Telephone Company, Limited,  
Oxford Court, Cannon Street, London, E.C.,  
5th July, 1890.

A. Erskine Muirhead, Esq., Glasgow.

Dear Sir,—We are in receipt of your letters of 26th and 28th ult., and in reply have to state that we cannot have the telephones left in Glasgow, but must now ask you to send them up to us here within a week.

You are quite in error as to your being able to do as you choose in December next, as stated in your letter of 26th ult., so far as our patents are concerned.—Yours faithfully,

T. BLAICKIE, Secretary.

The National Telephone Company, Limited,  
Oxford Court, Cannon Street, London, E.C.,  
19th August, 1890.

Mr. A. E. Muirhead, Glasgow.

French Telephone Instruments.

Dear Sir,—With reference to previous correspondence in this matter, we must ask you to be good enough to send these instruments in to our Glasgow office, in compliance with your offer to do so contained in your letter of 28th June, 1890.—Yours faithfully,

A. ANNS, for Secretary.

The National Telephone Company, Limited,  
Oxford Court, Cannon Street, London, E.C.,  
29th August, 1890.

A. E. Muirhead, Esq., Glasgow.

Sir,—As we have no reply to our letter of 19th inst., I have now to inform you that unless we hear from you on or before Wednesday next, 3rd September, we shall instruct our solicitors to proceed in the matter without further notice.—Yours faithfully,  
ALBERT ANNS, for Secretary.

#### A Phenomenon; indeed!

Will you please explain the cause of a phenomenon which occurred the other day? I was filling up some 23 L accumulators (new positive plates) with the usual solution of dilute acid, and the liquid was not particularly clean, so I put an iron gauze strainer across top of plates

This gauze was touching both poles of the cells, and when the acid reached it—the glass being then nearly full—a perceptible fusing was noticed between edges of gauze and poles of accumulator. Is this due to an electrical or a chemical action?

An answer will greatly oblige, and receive the thanks of

Hypothesis.

October 13th, 1890.

[If the gauze made a short circuit between the poles of the cell, we do not know what other result could be expected than the fusing of the metal. The fact that the occurrence did not take place until the acid reached it appears accidental only.—EDS. ELEC. REV.]

#### Candle-Power of Electric Lamps.

In your issue of the 3rd inst., you drew attention to the exaggeration of candle-powers in arc and incandescent lighting.

With arc lighting, I think most engineers take account of this and allow somewhere about 600 effective candle-power for an arc of 2,000 nominal C.P., as in the tests carried out at Berlin, but with incandescent lighting little or no reduction is needed.

As a matter of general interest I send you the results of some tests carried out at the Vienna Central Station in 1888. The lamps burnt out at the two Court theatres were replaced by the company, and as these amounted to somewhere about 25,000 per year, it was of the greatest importance to choose between the different makers. Five of each make were taken, and lighted from a constant pressure of 100 volts, the pressure of the lamps, the current being taken from a reserve battery and the pressure exactly adjusted. Each day the lamps were taken out singly and measured on the photometer, filament broadside on, and the sum of the candle-powers of each make plotted out.

#### Lamp Curves.—Watts per Candle.

Hours burning.	Swan.		Allgemeine Electric Ges.		Siemens and Halske.		Edison-Paris.		Khotinsky.	
	C.P.	Watts.	C.P.	Watts.	C.P.	Watts.	C.P.	Watts.	C.P.	Watts.
100	18.8	3.45	16.3	3.31	14.3	3.41	32.8	4.15	13.8	3.6
200	17.2	3.79	14.3	3.66	12.3	3.84	28.1	4.85	12.5	3.79
300	15.6	4.1	13.4	3.87	11.1	4.2	26.3	5.25	11.2	4.22
400	15.2	4.17	11.8	4.33	10.5	4.33	23.2	5.9	9.6	4.75
500	14.8	4.29	11.1	4.59	9.7	4.74	21.0	6.5	9.4	4.8
600	14.4	4.38	10.1	5.01	9.3	5.01	16.5	8.3	8.9	4.98
700	14.1	4.5	8.9	5.51	8.3	5.36	—	—	7.8	5.49
800	13.3	4.68	7.8	5.79	7.8	5.67	—	—	6.9	5.96
900	12.4	4.9	8.0	5.9	7.1	5.95	—	—	6.6	6.1
Average.	15.1	4.25	11.3	4.66	10.05	4.72	24.7	5.83	9.6	4.85

If a lamp broke it reduced the total height of the curve. The splendid instruments in the possession of this station ensure the reliability of these figures. Allowing for improvements in the Edison-Swan Company's manufacture during the last two years, and taking the mean candle-power as representing the mean effective illumination of a building, I think one can fairly speak of a 16 C.P. lamp at  $4\frac{1}{4}$  watts per candle with a life of 1,000 hours.

The fact of the matter is, that the present 16 C.P. lamp is the old 20 C.P. nominal. Mr. Preece, I believe, has made some valuable experiments in gas lighting at the General Post Office, which would bear on the case as regards the behaviour of gas burners under similar conditions.

S. T. Dobson.

October 14th, 1890.

WE have received a letter on "The Labour Question," but as the writer does not favour us with his name and address we hold it over. Perchance our correspondent may think fit to conform to our custom, and his communication will then appear in due course.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## THE CURRIE STORAGE BATTERY.

ABOUT this time last year we published an article from the pen of Mr. A. Reckenzaun on the secondary batteries shown at the Paris Exhibition. Among them was the Laurent-Cely accumulator, exploited and constructed by the Société Anonyme pour le Travail Electrique des Méteaux. The special feature of this invention consists in the nature of the active material, which is a mixture of chloride of lead and chloride of zinc. The fused chloride of lead has a density of 5.6; by incorporating chloride of zinc with it in certain proportions the density is reduced to 4.5. This mixture, brought to a state of fusion, is run into cast-iron moulds in the form of small buttons with rounded edges. When cool, the buttons are washed to remove the chloride of zinc, whereby a porous mass is obtained. Round these buttons is cast a frame of lead and antimony, when the plate is ready for formation. The negative plates are next placed in cells containing acidulated water, together with zinc electrodes, and charged. The hydrogen which is disengaged upon the positive electrode reduces the chloride of lead, and converts it into the metallic state.

A somewhat analogous process is used by Mr. Stanley C. C. Currie, of Philadelphia, and this is fully described in a recent number of the New York *Electrical Engineer*.

Commercial lead is first finely divided by a special process. This is dissolved in nitric acid and then precipitated as chloride of lead by the addition of hydrochloric acid. The white chloride of lead so obtained, after being thoroughly washed and dried, is mixed with a certain proportion of chloride of zinc and the mixture brought to a molten state in a furnace. The fused mixed chlorides are then poured into square moulds and allowed to cool. They are next placed into another mould prepared for their reception and a grid of lead cast around them, binding the blocks into a compact plate. The molten lead is forced around the blocks under pressure in order to ensure the best pos-

sible contact. The plates thus produced are then packed between zinc plates and placed into a tank containing a dilute solution of chloride of zinc. There is thus formed a voltaic couple, the action of which is to dissolve the zinc chloride and to extract the chlorine from the lead chloride, leaving spongy lead in its place. The last trace of chlorine is then removed from the plates by washing and then placing them in a tank containing nitric acid, and passing a current through them. The plates intended for anodes (positives) are formed into peroxide in dilute sulphuric acid.

The standard cell contains 9 positive and 10 negative plates, weighing together 34 lbs., and giving a capacity of 230 ampère hours; the plates are  $5\frac{3}{4}$  inches wide and 6 inches high.

The Germantown Electric Light Company, Philadelphia, uses 512 of these cells, arranged in 8 series of 64 each, having a combined capacity of 1,600 ampère-hours.

Mr. Currie has also designed several novel automatic devices used in connection with this storage battery plant. Among these is a "full-charge indicator," which consists of two strips of lead attached to a strip of ebonite. The upper ends of the lead strips carry a pair of binding screws and wires leading to an electric bell, whilst the lower ends of the lead are bent one over the other in such a manner as to leave a small air-space between them. The whole is suspended above the liquid of any cell. As soon as the battery is fully charged it begins to "boil," due to the rapid development of gases. This creates a spray of acid, which is projected upward, and some of it accumulates on the lead strips referred to until it forms a drop of liquid bridging the small gap between the two strips; circuit is thus established for the bell to ring, and notify thereby the attendant that the charging is complete. This device is, however, used in connection with an automatic cut-out, constructed on the usual electromagnetic principles. There is also an automatic apparatus for preventing reversals of polarity.

The Electric Car Company of America has been

testing Mr. Currie's storage batteries on four of their tramcars on the Lehigh Avenue Street Railway, Philadelphia, during the last four months. There are 100 cells, of the railroad type, on each vehicle. During the month of August 59,000 passengers were carried on this road, which has numerous curves and grades as heavy as  $5\frac{1}{2}$  per cent., whereby the batteries have been taxed to their utmost, the load on a car consisting, at times, of 100 passengers.

## THE ELMORE PATENTS.

No. 10,720, 1884. This patent refers to the construction of moulds in segments, with suitable patterns engraved or embossed upon their inner surfaces, upon which copper or other metal is electro-deposited, and the resultant used as rollers for printing or embossing patterns either on paper or other substances.

No. 1,737, 1885, is an improvement in detail on the 1884 patent for segmental moulds which can be easily removed from the deposited metal and re-used. The purposes of such moulds are not limited to the production of printing rollers, as in the previous specification.

No. 4,499, 1885, is for a core or mould of a metal or alloy whose expansive or contracting properties shall differ from that of the metal deposited, thus facilitating its removal under proper treatment from the deposited metal. Also for the employment in the solution or bath of a burnisher. Three methods of burnishing are shown—by a travelling tool, by continuous pressure, and by an oscillating movement. The claims for the burnisher are limited to its application within the solution of the bath. The reason for this is plainly set forth in the patent in the following words:—

"It is well known that when almost any metal is deposited electrolytically from its solution the deposit is more or less crystalline, and that this crystalline nature of the deposited metal increases to a certain extent with the increased action of the current, therefore I employ the process of burnishing carried on simultaneously with the process of depositing, without removing the mandril with its deposit from the solution or out of a solution, and so the deposited surface is burnished without bringing it into contact with the air, and I carry on these two processes substantially as set forth."

No. 8,707, 1885, is for a system of making copper tubes by a combined electric and drawing process—that is to say, the preliminary formation of a block or "use" is by electro-deposition, this block being drawn down over a mandril through dies in the usual way; also the particular process described for freeing the tube from its mandril; and the manufacture of corrugated or spiral tubes by depositing the metal upon a core whose corrugations are of a screw-thread form, and this mandril, after a particular treatment described, can be withdrawn from the tube.

No. 10,451, 1885. This patent applies the burnishing principle to metal articles, such as pans, containers, and

the like. It protects the combination of a rotating core with burnishers. The claims do not expressly submerge the burnishers, but the drawings do.

No. 11,800, 1885. This patent, an improvement on the four foregoing inventions, relates to a process for the deposition of copper in the manner described in previous patents, and for simultaneously refining impure copper, or extracting the metal from its ore. The economy of this is shown in the specification by the statement that the two things are done at "practically the same cost as would be incurred in carrying out either process separately."

No. 9,214, 1886. This patent applies the burnishing process to the covering of plates, wires, &c., or the deposition of metal into the form of sheets or bands. It introduces a revolving burnisher, and it claims the use of an endless band surface, or a continuous drum surface of lead coating or alloy, for receiving the initial deposit.

No. 16,637, 1887. This patent practically claims the obtaining long continuous bands from electrically-deposited copper by any suitable method.

No. 11,778, 1888. This patent provides for the application of a rolling or hammering action on the deposited coating during the process of deposition, instead of the burnishing. For this purpose the mandril has to be partially out of the solution, and a cover provided which ensures the return to the bath of any portions of the deposit which may be hammered off.

No. 12,022, 1888. This patent claims to protect the method of depositing copper at very high temperatures, and simultaneously submitting it to mechanical treatment. It is claimed that tubes made in this way will be more suitable for use as steam pipes, &c., than as commonly made.

No. 12,264, 1888. This patent refers to the moulds or cores, and claims to cover the use of a coating of lead or tin, for the double purpose of filling up any crevices which may exist in the main core, whether consisting of a single piece or a combination of separate pieces, and of preventing injurious action of the solution in the event of the core being of iron.

It is not our intention to comment on these patents in detail. It will be seen that some of them are not very nearly related to the main question, whilst others are of a subordinate character.

Each is doubtless an improvement in its respective sphere, and may be of considerable value, but does not control an industry. Attention has been rightly directed more particularly to the burnishing process, commencing with 4,499 of 1885, and the improvements on the original plan, or its application to different articles, which follow in later patents. It is necessary to draw a distinction between a patent which enables a certain thing to be done in one of several ways, and a patent protecting an article or a process which cannot be obtained in any other way. Electro-metallurgy is a science of respectable age. Electro-deposition is not new. Patents, therefore, on these subjects are necessarily restricted to the particular processes described. For example, the essence of the Elmore process is the combination of electrical deposition with

mechanical treatment; but the patents must be limited to a particular form of electro-deposition, combined with a particular form of mechanical treatment, and a monopoly can only exist on the assumption that no other forms are practicable.

Supposing the Elmore process to be a valuable invention it will, according to all precedent, meet with imitators. There is an unfortunate tendency on the part of a large number of people to have a hand in a revolution if they can. In such an event the Elmore Company would rightly fall back upon its patents for protection, proceeding against trespassers with all the rigour of the law. Assuming the novelty of the process they might reasonably claim, and, in our opinion, deserve, a "benevolent" construction; but when it is remembered that in 1885 (No. 4499) the mechanical treatment was considered to be essentially conducted within the solution and so protected in the form of burnishing, whilst in 1888 (No. 11,778) the mechanical treatment was found to be possible out of the solution, and so protected in the form of hammering, there seems to be little room even for a benevolent interpretation should some evil-disposed person take the burnisher of one patent and apply it in the manner reserved for hammering in the other.

Considering the amount of money paid for these patents, and the extensive financial developments to which they have given rise, it seems surprising to have to record that they have not yet received that *cachet* of validity—extensive work and immunity from attack, nor have they been through the fire of the Courts and come through unscathed.

## THE ELECTRO-DEPOSITION OF COPPER.

IN last week's issue we referred to the various points involved in the electro-deposition of copper, and we laid before our readers certain details which were intended to enable them to form a more correct judgment on a certain process than had hitherto been possible except to the well-versed in electro-technical industries. We showed that in a German establishment the practical electro-deposition of copper involved an expenditure of 900 horse-power hours per ton, and that the daily output was 1,760 lbs. per day of twenty-four hours; approximately, about 5 tons per week of 144 hours.

In Dr. Hopkinson's report on the Elmore process, he estimates that with 60 tanks, working 161 hours a week, there will be produced 18,000 lbs. of tube, say 8 tons, and as our readers are already aware, the calculated cost of production did not exceed £5 per ton.

We have had several enquiries from the uninitiated public asking the meaning of Dr. Hopkinson's figures, for to some people it appears that the expression, "the net result of my observation is that a ton of copper can be deposited in steady continuous work by a consumption, with good engine and boiler, of less than 1½ tons

of coal, costing 8s. 6d. per ton," gives rise to the belief that this is the total cost for motive power.

Now the output of the two establishments named is sufficiently close to enable a comparison to be made, so if we take 900 horse-power hours at even so low a rate as ½d. per horse-power, we arrive at a sum of, say, £2 for motive power alone, but this sum would probably be doubled in practice.

When it is borne in mind that the electrolytic method of refining copper is carried on in various places under totally different circumstances, and that it is not to the advantage of manufacturers to make public the details of their processes for securing the most economical results, it is evident that any published data in this connection, especially when merely hypothetical, must be received with caution; but the following figures, given by M. Fontaine, if not absolutely correct, have the advantage of being derived from actual practice:—

Factories taken as examples.	Expenditure per ton of refined copper.					
	Interest on capital.	Motive power.	Maintenance.	Labour.	General expenditure.	Total.
	Frs.	Frs.	Frs.	Frs.	Frs.	Frs.
Hilarion Roux, Marseilles .....	78.80	112.00	18	72.00	108.0	388.8
North German Refinery, Hamburg .....	64.65	39.50	12	40.0	40.0	196.0
Elliott Metal Co., Birmingham...	35.95	180.06	30	57.75	57.75	361.45

"The cost of fuel in Birmingham," says M. Fontaine, "is much lower than we have taken as a basis, but taking it at 5s. per ton at the works, we find that the motive power still costs 125 francs per ton of copper. If we leave the other figures unaltered, we obtain a total of 306.45 francs, that is to say, a much greater expenditure than at the Hamburg works. The interest on the capital engaged represents a small proportion only of the cost price, whereas at Hamburg it constitutes the main expenditure."

When we take into consideration the large amount of what may be briefly described as dead capital, the cost of production would have to be low indeed to allow of anything like the high dividends pre-shadowed in the prospectus of the various companies, especially when it is remembered that the process is a new one, in which a good deal may have to be learnt and paid for before even wire can be supplied commercially.

Dr. Hopkinson is probably correct so far as his estimate of fuel is concerned; but if the data given above represents the real expenditure entailed in electrolytic operations, then it looks as if his calculation of £5 per ton must be trebled.

We will now turn to another phase of the Elmore scheme.

Amongst the advantages claimed for this process is that "the electrical conductivity of the annealed copper has a conducting power of 4½ per cent. above that of the best guaranteed commercial copper." This statement has evidently been made upon the strength of the report of Messrs. Clarke, Forde and Taylor, an extract from which appeared in the various prospectuses of the

Elmore Copper Company that have been placed before the public on different occasions, and to which we have already alluded. They state, "your annealed copper has a conductivity of  $4\frac{1}{2}$  per cent. above that of the best commercial copper." Now, in the prospectus of Elmore's Patent Copper Depositing Company, Limited, the conductivity of the copper was, if we rightly remember, stated to be 102 per cent.; it would, therefore, appear that Messrs. Clarke, Forde and Taylor have based their calculations on commercial copper at  $97\frac{1}{2}$  per cent., which is, according to English manufacturers, a very fair basis. In France, however, the well-known firm of G. O. Mouchel, which owns perhaps the largest and oldest copper manufactory in France, has for some years paid special attention to the manufacture of copper wire for electrical purposes, and as far back as 1885 it was commercially supplying copper wires with a guaranteed conductivity of 100 per cent.

At the Inventions Exhibition, held in London in 1885, Messrs. Davis and Timmins, Limited, who were, and still are, the sole agents in England for Messrs. Mouchel, exhibited a large quantity of wire, guaranteeing the conductivity to be not less than 100 per cent., and the firm has since that date been supplying large quantities of similar wire with the same guarantee. We have been assured by Messrs. Davis and Timmins that, although they only guarantee 100 per cent., the bulk of the wire will be found considerably over this. At the official tests made at the International Exhibition of Antwerp in 1885, it was found that annealed commercial copper wire manufactured by G. O. Mouchel had a conductivity of 104.15 per cent., with an elongation of 40 to 60 per cent. From the above facts, it is evident that neither Messrs. Clarke, Forde and Taylor, nor the directors of the Elmore Company, were aware of what had been done in France as regards the conductivity of copper, and this appears all the more strange, as for the last five years Messrs. Davis and Timmins have been, as agents for G. O. Mouchel, constantly advertising.

In the usual contracts for copper wire for electrical purposes, a minimum of 96 per cent. conductivity is stipulated, and so long as this is the case, it would rather appear that, from a manufacturer's point of view, one would not feel inclined to pay a higher price for wire in order to ensure a higher conductivity; this being so, the fact of Elmore copper being stated as of a higher conductivity than the ordinary English wire would not necessarily command for it any advance in price over the present commercial copper.

Now the Elmore process for the manufacture of copper wire is, commercially speaking, untried, and it may be often noticed that what is originally claimed in prospectuses of companies put before the public, do not afterwards, in commercial practice, work out quite so well. On the other hand, at Mons. G. O. Mouchel's factory the manufacture of copper wire has been carried on commercially for some years on a very large scale. Therefore one can hardly admit the great advantages in high conductivity copper wire in which one would be led (or, rather, misled) to believe by the Elmore prospectus.

## THE LANE-FOX PATENTS.

WE hear from several quarters that Mr. Lane-Fox and his associates are contemplating taking action against a number of people with regard to their using their dynamos, accumulators, and incandescent lamps in conjunction with each other. Also, that many of the persons who have been notified have been innocent purchasers of plant which they have installed for their own use, and who question the policy of individually contesting this action, seeing that the terms under which they may now compromise appear comparatively reasonable. We think, however, that the mere fact of licenses having been applied for and granted to the uninstructed public, is no evidence of the justice of the patentee's claims, and it would be far better to test the issue with those who are fully acquainted with the subject, and who would be able to defend themselves on the merits of the case *per se*. We are credibly informed that the licenses which have been granted to the Brush Company, for instance, were so granted in consequence of that company, when they relinquished the Lane-Fox patents, having retained the right of working under them, and they can in no way be construed as a recognition by the Brush Company of the pretensions put forth by Mr. Lane-Fox.

We also hear that Mr. Lane-Fox does not limit his claim to the use of a dynamo accumulator, and lamps running in parallel together with a practically constant potential, but likewise claims the use of a battery if charged separately and then discharged; and if a battery be charged from a dynamo, and then discharged, and the battery is employed for running two or more lamps at the same time, he considers that an infringement of his patents. If this be so, to our mind it is a perfect absurdity,—he might as well apply for a patent for the discharging of batteries for lighting purposes.

But apart from all this, we would call on the lighting public, who are, or may be, threatened, to ask Mr. Lane-Fox on what grounds he can pretend to the rights he claims, for we have evidence that incandescent lamps in the form of platinum wires or strips were operated from batteries as far back as 1859, by Prof. Moses G. Farmer, in Salem, Mass., and believe that the house can be shown to-day (or, at any rate, it was a few years since), with the wires remaining in it where these experiments were made and demonstrated, and pamphlets were published with accounts of this matter before the date of Mr. Lane-Fox's patent. Also, at the Paris Exhibition of 1877, the Planté battery was exhibited by Messrs. Breguet, and there one might have seen the combination of a hand Gramme machine charging a Planté accumulator, and discharging its current through incandescent platinum wires. We think there will be no difficulty in proving, from several sources, that that combination was publicly in operation at that exhibition, as well as M. Gaston Planté's laboratory, and at the show rooms of Messrs. Breguet, in Paris. We would therefore advise the public to hesitate before even paying a small acknowledgment of the patents to the Lane-Fox Association in order to save them-

selves trouble. And we would more strongly advise Mr. Lane-Fox and his friends not to commence their attack on the innocent customer for electrical plant, but to test their position with foemen worthy of their steel either in the courts, or, still better, by discussion among a certain number of men who could, at a much less cost, show that the claim for the discharge of a secondary battery through electrical incandescent lamps in parallel is preposterous and absurd.

PERHAPS no epoch in the history of metallurgy has been so marked as that comprised within the last few years.

That period has witnessed the development of the processes for producing aluminium and the consequent great reduction in the price of that metal. This price, however, requires to be brought down to a still lower level before the manifold uses to which the material can be put become capable of great extension. Simultaneously with the reduction in price of aluminium has followed an increase in the price of platinum, a metal which to the chemist and electrician is invaluable. This increase in price has been such as to augment the value of the metal by three times what it was only a few years ago. How important a factor this is may be recognised by the fact that the cost of the platinum leading-in wire of an incandescent lamp is the largest single item involved in the cost of manufacture. How far workable platinum ores are distributed over the globe appears yet to be very imperfectly known, but a recent discovery at Colac, Australia, appears to show that there is hope that a fairly abundant supply of the metal may yet be forthcoming. It is stated in the *Ballarat Courier* that samples of the ore taken from the Otunz Ranges give a return of 1,120 oz. per ton, and that great excitement reigns in the district. Certain doubts have been cast upon the genuineness of the discovery, but it is to be hoped that there is something more than a grain of truth in the announcement.

Welcome Little  
Stranger.

NOBODY seems to have taken much notice of the announcement made three weeks ago, that Messrs. Swan,

Sonnenschein were to publish for the first time on the 4th October, a new penny weekly paper entitled *Electricity*, the editor of which is to be Dr. Julius Maier. The new paper has not yet appeared, and on enquiry of the publishers it was ascertained that the journal would be born on the 15th November. There is, however, already a possessor of the title, for on Saturday, March 29th last, *Electricity*, a weekly newspaper and technical journal first saw the light of day. The publishers were Messrs. Hampton, Judd & Co., of 14, Duke Street, Adelphi, W.C. The second number appeared on April 5th, but after a fortnight's existence it fell into a decline and died. It had, however, been intended to resuscitate the deceased as a penny monthly paper, but the process of cremation had entirely destroyed its vitality and it has never, as far as we can ascertain, again seen daylight. Nevertheless, the fact of the previous existence of *Electricity* does not appear to have been known by the promoters of the new journal until quite recently, and this is the reason for the delay in its publication. We believe the question of copyright is now agitating the minds of the owners of the old and the publishers of the new *Electricity*.

An Electrical  
Collapse.

A SHORT time ago a monthly contemporary came out with a grand flourish of trumpets announcing that in consequence of the progress taking place in electrical applications, it would in future devote a portion of its valuable space to electrical matters. For a short time volts and amperes were thick in the air, while Mr. R. E. Crompton received polite attentions in the way of portraiture and otherwise. This was, however, too good to last. Whether it be that our contemporary has become frightened over electrical nomenclature, or whether it has exhausted its knowledge of the subject we of course do not know, but the peculiar fact remains that, while in one month's issue there was no electrical matter, a spasmodic attempt at revival in the current number has only resulted in a brief notice of Bristol's mining lamp, which is now a matter of ancient history.

Storage Battery  
Explosions.

THE explosion which took place on board Earl Poulett's steam yacht is by no means an isolated case, and our readers will recollect the explosion on one of the Barking Road cars, which shattered all the windows into fragments. Fortunately no one has ever been injured by such accidents, and we are inclined to think that, as a rule, the force of these explosions is not sufficiently great to do more than split the receptacles, although the noise accompanying the action is loud enough to affect even the strongest nerves. These explosions never occur when the cells are open at the top and used in a well-ventilated place. The batteries were actually on the yacht's deck, where there should be plenty of air to carry off any hydrogen gas developed by over-charging; but the boxes were provided with lids having only a small vent hole, thus preventing a ready escape of gas, which might have been just sufficiently mixed with atmospheric air to produce disastrous effects when Lord Poulett struck a wax match and accidentally ignited some of the escaping vapour, which speedily communicated heat to all the neighbouring cells, and probably exploded the whole series simultaneously. This incident caused much alarm; a daily paper states that "electricians could in no way account for it, as it had hitherto been thought that under no circumstances could gas be generated." Mr. Reckenzaun tells us that he experienced explosions with covered cells, having vent-holes, as early as 1882, also at different periods since then, but that neither he nor any one else had been seriously hurt, and that a sufficient supply of air, cells completely sealed, or quite open at the top, will be an efficient safeguard against mishaps of this description. Overcharging of storage batteries must evolve hydrogen, which, if accumulated in a close atmosphere, will produce one of the most explosive compounds when ignited. We give amongst our "Notes" the description of this little mishap as the *Daily Telegraph* has it, but the reference to Earl Poulett's electricians is utterly absurd. His technical adviser knows perfectly well that under certain conditions such mishaps as the one under notice may occur, and the remarks of our gaseous contemporary are therefore quite uncalled for. It is more than probable that as the incident occurred some two months ago the memory of the narrator of this pretty story is at fault, but nevertheless we may point a moral to adorn the tale: never allow these gases to accumulate, and don't search for free hydrogen with a lighted match.

## THE FALL OF POTENTIAL AT THE CATHODE IN GEISSLER'S TUBES.

It has been observed by E. Warburg that whilst in a Geissler tube filled with slightly moist nitrogen the difference of potential between the cathode and a point in the extreme visible limit of the negative glow remained constant, yet when the nitrogen is quite dry a considerable increase of fall takes place as the current passes [*vide* Gilbert's "Annalen der Physik und Chemie," series [2] Vol. XXI., page 545].

This observation has recently been under investigation again, and Warburg now attributes the phenomena to the presence of minute quantities of oxygen in the nitrogen, and shows in a paper in Gilbert's "Annalen," &c., series [2], Vol. XL., page 1, how these traces of oxygen may be removed. Sodium had previously been used for this purpose, but a difficulty was experienced in obtaining this metal in a state of sufficient purity.

Warburg now liberates his sodium within the closed tube in a nascent state by electrolysis through the glass, a portion of the tube being immersed in half per cent. sodium amalgam connected with the negative pole of a battery and heated to 300° C., the cathode of the tube being connected with the positive pole. When the last trace of oxygen has been removed a deep yellow light appears in the part of the tube where the sodium is liberated.

Nitrogen at 2·3 mm. pressure was freed from oxygen in 20 minutes with a current from three Bunsen cells connected with an induction coil capable of giving a 25 mm. spark in air, and making 390 contacts per minute. The excess of sodium was afterwards distilled into a remote portion of the tube. From his experiments Warburg gets the following mean numbers for the fall of the cathode in volts :—

Platinum cathode in	nitrogen	=	232	volts.
"	"	"	hydrogen	= 300 "
Magnesium	"	"	nitrogen	= 207 "
"	"	"	hydrogen	= 168 "

Variations of a few per cent. still remain, but the author is of opinion that in perfectly pure gases the fall is independent of the current strength and of the pressure, being determined only by the chemical nature of the gas and of the cathode, and by the physical condition of the latter.

## THE ACTION OF THE ELECTRIC ARC ON GASEOUS SUBSTANCES AND ITS EMPLOY- MENT FOR DEMONSTRATIONS.

THE action of electricity upon various simple and compound gases has, as our readers well know, engaged the attention of physicists and chemists for many years. A few weeks ago we gave some account of an investigation into the behaviour of certain gases under the influence of the silent discharge [*vide* this paper, September 19th, 1890]. We have now to call attention to some recent work by a German scientist, namely, Herr B. Lepsius.

Lepsius has been studying the action of the electric arc on certain gaseous substances. During the course of his work he has designed an exceedingly interesting apparatus, which can be successfully employed for demonstrating the volumetric composition of various gases. The law of combination of gaseous elements and compounds by volume, which was enunciated in 1808 by Gay-Lussac, has not yet been subjected to as rigorous an examination as that which the laws of combination by weight have undergone.

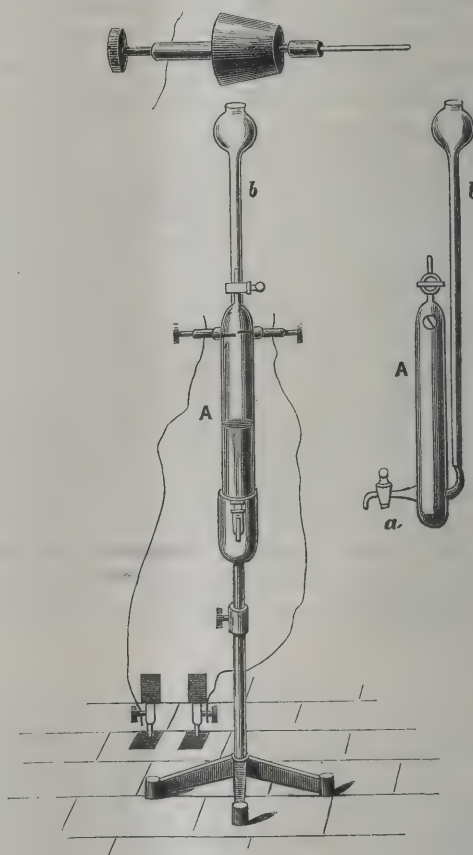
The laws of chemical combination, in so far as they concern the gaseous elements, may be summed up in the following statement: "The gaseous elements combine in the ratios of their combining volumes, or in ratios

which bear a simple relation to these." By combining volume, is here meant the smallest volume of a gaseous element which combines with unit volume of some specified gaseous element taken as a standard. The laws of "combining weights" have been amply verified by accurate experiments; but the laws of "combining volumes" does not stand on so firm an experimental basis.

It is evident, from what is stated in the preceding paragraph, that there is room, if not a demand, for improved methods and apparatus which shall be useful in studying the volumetric composition of gases.

There is already existing a form of apparatus invented by Hofmann, by means of which much good work has been done, but there are certain objections to it; for instance, it can deal only with small quantities of gas, and then the experiment takes a considerable time.

Lepsius's new apparatus depends for its efficiency upon the action of the electric arc. The accompanying sketch gives a very fair view of it. The essential features may be thus described.



A glass tube, A, 40 mm. in diameter and 300 mm. in length, is provided at its upper extremity with a glass stop-cock, and, 40 mm. below the stop-cock, with two lateral tubes, 15 mm. in length and 15 mm. in diameter; it is closed below, but provided with a stop-cock, a, and an upright tube, b, 10 mm. in diameter, as shown in the figure, the whole being placed on a suitable support. The lateral tubes serve for the introduction of the carbon poles, which are about 2 mm. in diameter (or larger if required), and enclosed in metal necks 12 mm. in length, which on the other side fit on the pin (2 mm. in diameter) of a copper rod (6 mm. in diameter), provided with a binding screw.

The metal necks are made of iron or of brass—in the latter case they must be lacquered—and are slit down on one side. The copper rods are fitted tightly into the lateral tubes by means of India-rubber corks, and are of such a length that they overlap each other about 10 mm., the corks being placed eccentrically in the tubes in such a manner that the rods can be brought into contact by slight pressure on one of the binding screws.

A potential difference of 30 to 50 volts is sufficient to give the necessary arc, but it is better to employ, say 60 to 80 volts, and a rheostat; the heat of the arc can then be regulated, so that the glass apparatus and the India-rubber corks are not damaged.

The gas is introduced in the usual way by first filling the apparatus with mercury.

Those who have ever been called upon to lecture before the public or a number of students, and have wished to demonstrate in an intelligible way the volumetric composition of gases, have probably been much inconvenienced by the insufficiency of the commonly known methods for this purpose. Lepsius' new apparatus, which of course is not patented, but may be the common property of all students of science, will, as the advertisements say, "supply a long felt want" in this direction, and, moreover, will prove of the greatest value in demonstrating the truth of certain hypotheses, and in placing the laws of combination by volume upon a sound experimental basis.

The following examples will serve to illustrate the use of the apparatus:—

*Conversion of Carbonic Anhydride into Carbonic Oxide.*—From 80 or 100 cc. of well dried carbonic anhydride is introduced into the apparatus, its volume measured under the atmospheric pressure, is marked on the tube, and the arc is ignited. Decomposition takes place with a brilliant light, and the volume immediately increases; in about a minute decomposition is complete, and after a short time the temperature is sufficiently equalised to allow of the measurement of the carbonic oxide, the volume of which is found to be double that of the carbonic anhydride employed.

*Conversion of Oxygen into Carbonic Oxide.*—About 100 cc. of well dried oxygen is introduced into the apparatus, its volume is noted and the arc ignited; the volume increases continuously, and in one or two minutes the oxygen is completely converted into double its volume of carbonic oxide.

The volume relationship between oxygen, carbonic oxide and carbonic anhydride can be conveniently and quickly demonstrated with a modified form of apparatus, a diagram of which is given in the original paper by Lepsius [*vide* "Berichte der deutschen Chemischen Gesellschaft, Vol. xxiii].

*Conversion of Sulphurous Anhydride into Carbonic Oxide.*—About 80 cc. of dry sulphurous anhydride is introduced into the tube A, shown in the figure; the volume is measured under atmospheric pressure, and the arc is ignited; the carbon burns with a beautiful blue light, the apparatus becoming filled with white fumes; the volume of the gas increases, and reaches a maximum in about 30 or 40 seconds. On measuring the volume of carbon monoxide produced, it is found to be double that of the sulphurous anhydride employed.

That acetylene contains its own volume of hydrogen can also be demonstrated by means of the apparatus shown in the diagram.

This apparatus can be conveniently used for showing means of the electric arc. For this purpose a flask, 15 the formation of water-gas when decomposing steam by to 20 cm. in diameter, is provided with two lateral tubes, through which pass the carbon poles, arranged and adjusted as described above; the mouth of the flask is closed with a cork, through which pass two glass conducting tubes, one reaching almost to the carbon, the other just passing through the cork; the flask is inverted on a stand, and steam is passed in through the longer tube.

As soon as the air is completely expelled, the escaping steam is led under an inverted cylinder full of cold water; if now the arc be ignited, a rapid evolution of gas, consisting of equal volumes of hydrogen and carbonic oxide, is observed.

The same apparatus can be used for showing the formation of water gas from water. The flask, provided with a single delivery tube, is filled with water, placed in an upright position, and a strong current passed; the carbons become white hot, and a mixture of hydrogen and carbonic oxide is rapidly evolved."

## THE ELECTRIC LIGHTING OF MONACO.

[FROM A CORRESPONDENT.]

IN the beautiful but notorious sea-bathing and gambling town, Monte Carlo, a central station for the electric lighting of the town is in course of erection, and is to be shortly brought into play. The concession for this undertaking was granted in February last to the firm of Lombard-Gerin & Co., of Lyons, by the Government of the Duchy of Monaco, for the entire territory of the state. Thereupon the above firm founded a company for carrying out the concession under the style Société Monegasque d'Electricité, having its registered office at Monaco. This company, which was constituted with the co-operation and participation of the Société des Bains de Mer et du Cercle des Etrangers at Monaco, is erecting and otherwise carrying out the above-named electrical works.

The concession for this undertaking was granted on very favourable conditions. For the edification of other projectors, I will recapitulate the more important stipulations.

Article 2 of the concession secures to the company the exclusive right to utilise the public domains of Monaco for laying down leads, underground or aerial, for the distribution of electric currents, whether for lighting or for the transmission of power.

This exclusive right, however, does not interfere with the existing rights of the Société des Bains de Mer, which had previously obtained a concession for laying electric leads for lighting the buildings which are at present its property.

Article 4 fixes the duration of the concession at 50 years, but after the expiry of 25 years the Government may cause the concessionaries to adopt any new means for the more rational distribution of the electric current if they have been found satisfactory in practice.

Article 6 provides for the reversion of the entire conductive network to the town of Monaco after the expiry of the concession. The buildings and the internal plant of the central station remain the property of the company; but the town has the right to purchase them at a price to be judicially determined.

Article 7 gives the concessionaries the right to use the Zipernowsky-Déri-Bláthy system of distributing the current by means of alternating current transformers. The primary tension must not exceed 3,000 volts, and 120 volts is fixed as the limit for the secondary E.M.F.

Article 12 prohibits the use of the earth for the return current. The underground cables must have a single or, if needful, a double lead coating, unless they are laid in wooden boxes or earthen pipes, protected with metal sheathing. The joints for connection and distribution must be fixed in cast iron boxes carefully insulated.

Article 16 binds the projectors to supply current to every subscriber within the line of the streets traversed by the leads. To subscribers beyond such streets, current can be supplied only on condition that they undertake the entire cost of the connection from the nearest point of the conductive network.

Article 17 binds the company in all cases to lay at their own cost the primary conductor for the electric lighting of the ducal palace and the palace of the Governor, and to supply the necessary transformers. The expense of the secondary conductors and the internal fittings in these buildings fall upon the government. In return for the grant of the concession, the projectors are required to supply yearly, without charge, sufficient current for 50,000 10-candle glow-lamp hours of burning, whilst the Government is to pay for any current in excess of this quantity at the figure required from the most favoured consumer.

Article 18. The Government places the ground necessary for the erection of the works at the disposal of the projectors gratuitously for the total duration of the concession.

The work is already in full progress. Two alter-

nating current machines of the Zipernowsky type A<sub>6</sub> (each of 80,000 watts), together with the necessary exciters and transformers, are already set up, and a third machine will shortly be added.

The entire materials for this central station (both the motors and the electrical machines and apparatus) are being supplied by the firm Schneider & Co., of Creusot.

### PASCHEN'S RESEARCHES ON POLARISED MERCURY.

STUDENTS of electricity are familiar with the common laboratory experiment of putting a drop of mercury in some dilute sulphuric acid which contains a trace of chromic acid, and then so fixing the end of a piece of bright iron wire that it dips in the acid, and at the same time just touches the edge of the mercury; under these circumstances, the wire commences a series of regular vibrations which may last for hours.

The usual explanation of these interesting phenomena is as follows: An iron mercury couple is formed when the piece of wire first touches the edges of the globule of mercury; the effect of this is that the surface of the mercury becomes polarised by a thin layer of hydrogen gas, the surface tension of the mercury is consequently increased, the globule becomes more convex, and contact with the iron is for the moment broken. The chromic acid now comes into play, the mercury is depolarised, and the original "flattened-globular" form is restored; the couple is thus formed again, and the same phenomena are repeated and a vibratory movement ensues.

The above experiment, owing to its remarkable character, attracted the attention of the leading electricians of the day when it was first discovered, but its true significance was scarcely appreciated until Lippmann began to work upon it. Lippmann, during the course of his investigation, was led to some experimental results which have demonstrated a marked relation between electrical and capillary phenomena.

One of the most important results accruing from Lippmann's work on those phenomena was the construction of his capillary electrometer. Few readers of this paper probably require to be enlightened upon the subject of Lippmann's capillary electrometer, and detailed description of it may be read in any good textbook. It can estimate very small electromotive forces, and as its electrical capacity is very small, it can show rapid changes of potential. It is not generally recommended for greater electromotive forces than 0.6 of a Daniell.

A short time ago F. Paschen published a paper in "Gilbert's Annalen der Physik und Chemie" (*vide* Series [2], Vol. XXXIX., page 43), in which he discussed the variations which take place in the surface tension of polarised mercury in different electrolytes. In the course of the researches described in this paper Paschen states that he found Lippmann's capillary electrometer, whilst yielding excellent results for electromotive forces of less than 0.9 volt, was quite untrustworthy for values above this limit, on account of the polarisation caused by the liberation of hydrogen gas at the meniscus.

Since Lippmann's electrometer is thus found unreliable, Paschen employed a simple apparatus which, though not so delicate, can be used for large electromotive forces. It consists essentially as follows:—An open U-tube is taken, having one limb about 24 mm. in diameter, whilst the other is somewhat shorter, and only 3 mm. in diameter. The tube is so far filled with mercury that the meniscus reaches the top of the narrow limb. The whole is immersed upright in a beaker containing dilute sulphuric acid and a layer of mercury, so that the meniscus in the shorter limb alone is below the surface of the liquid. Connection is made with the meniscus through the wide limb.

By means of this instrument Paschen investigated

the change of surface-tension of mercury occasioned by polarisation in solutions of sulphuric acid, hydrochloric acid, sodium hydroxide, and various salts. He found that all changes of surface tension take place between the limits of + 0.1 and - 2 Daniell, and in the original paper curves are given which show that up to the maximum it is the anion that exerts the decisive influence, whilst beyond the maximum it is the cathion. The position of the two characteristic points of the curves, the maximum and the point where the electrolysis becomes evident, would appear to depend greatly on the concentration of the electrolytes.

In Lippmann's electrometer, and in Paschen's instrument also, the polarisation seems to be entirely at the meniscus and not at the large anodic surface. When the polarisation attains a constant value the surface-tension also becomes constant.

Temperature influences the results slightly, but not to such an extent as to interfere with the accurate working of the instrument under ordinary conditions.

Since these results were published Paschen has been continuing his researches upon the surface-tension of polarised mercury, specially considering the effect of concentrating the electrolytic solution and seeking to test Pellat's relation between the maximum of surface tension and the point where electrolysis begins.

An account of these experiments may be read in Gilbert's "Annalen der Physik und Chemie," series [2], vol. XL., p. 36.

For sulphuric and hydrochloric acids Paschen found that the maximum increases with increasing concentration, whilst the electromotive force for incipient electrolysis diminishes. It thus happens that for a definite mean concentration the two values become equal, so that it is only for this concentration that Pellat's relation holds good.

The fall beyond the maximum depends on the relative values of the electromotive force for maximum surface tension and for electrolysis. There is little or no fall for strong solution of hydrochloric and sulphuric acid, when the electromotive for electrolysis is far below the maximum.

Other electrolytes investigated by Paschen were solutions of nitric acid, ferrous sulphate, potassium hydroxide, potassium iodide and mercuric cyanide. Nitric acid and ferrous sulphate behave very similarly to hydrochloric acid.

The point for electrolysis is affected by the nature of the solvent. A strong solution of potassium cyanide behaves abnormally, giving a deflection of the meniscus in a direction opposite to that when other electrolytes are employed.

Experiments have also been carried on by Paschen with the so-called Wood's metal used instead of mercury, but the results have been identical in character.

### NEWSPAPER OFFICE ELECTRIC LIGHTING.

THE electric light installation for the new offices of the *Bolton Evening News* has just been completed by Messrs. Ernest Scott & Co., Close Works, Newcastle-on-Tyne, electrical and general engineers.

The installation is said to be one of the most complete, if not the most complete, in Lancashire, and lights the entire premises. The arrangement of lamps is as follows:—

Basement ...	...	46 lamps of 16 candle-power
Ground Floor ...	58	" "
First Floor ...	127	" "
Offices ...	45	" "
Entrance ...	1	" 200 "
Manager's Office ...	1	" 100 "

The whole of the lights throughout the building, with the exception of the offices, are pendants, and each lamp is fitted with a switch, secured to the pendant, so that every lamp in the installation can be switched on or off in the same way as gas.

There are two dynamos to drive the installation of Messrs. Ernest Scott & Co.'s standard "Tyne" type. Each machine is constructed to give an output of from 90 to 100 ampères at an electromotive force of 105 volts, the speed of each machine being 900 revolutions per minute.

As gas engines are used as the motive power for driving this installation, each dynamo has been fitted with a very heavy turned flywheel, supported on an outer bearing, and it has been found that the lights are perfectly steady, which is a result not very often obtained with gas engines unless special precautions are taken.

The current from these dynamos is taken to a main switchboard of a very handsome and massive description. The switchboard consists of an enamelled slate slab, about 5 feet long by 4 feet wide, and is fitted with two of Messrs. Ernest Scott & Co.'s improved coupling switches for connecting the two dynamos in parallel. Four double main switches, with fusible cut-outs on both positive and negative poles, are also mounted on the main switchboard. These switches are used to control the four departments, *i.e.*, basement, ground floor, first floor, and office.

Measuring instruments are also mounted upon the main switchboard, and by simply pressing the key, the pressure and quantity of current can be instantly measured. The enamelled slate base is mounted in a deep oak frame.

The office fittings are extremely handsome, and consist of five polished brass pedestals for the counters, eight polished brass brackets for the desks, one pendant with cut glass globe for the main entrance, containing a 200 C.P. lamp, and a pendant containing one 100-C.P. lamp for the manager's office.

This installation has now been running for some time without a hitch of any kind, and has given every satisfaction.

Messrs. Bradshaw and Gass, of Bolton, are the architects for the new buildings, and have throughout superintended the electric lighting arrangements, and much credit is due to them for the care and attention they have bestowed upon this matter.

INFLUENCE OF ELECTRIC TENSION ON  
THE INSULATION OF CABLES.\*

By A. PALAZ.

THE importance of a good insulation of electric leads grows continually greater, especially since the use of high tension currents becomes more and more general, the rather because the insulation decreases in proportion as the tension of the current increases. This fact was first mentioned by Herr Uppenborn.

The exact determination of the variations of the insulation with the tension of the current presents the greater interest as it enables us to determine if a cable has a tendency to modify the nature of its insulating material in consequence of the prolonged passage of a high-tension current.

*La Lumière Electrique* has recently summed up the measurements of Herr Fordenreuther relative to the determination of the insulation of electric conductors, in the course of which this physicist has incidentally touched upon the question which forms the subject of the present memoir. But this question has quite recently been studied in a thorough manner by Herr C. Heim, of Hanover, who has published his results in the last numbers of the *Electrotechnische Zeitschrift*.

The measurements of Herr Heim have reference to two cables coated with lead and insulated with jute saturated with resin or a mixture of different waxes, as also upon a core insulated with gutta percha. They have been effected by the aid of the ordinary method

which consists in measuring the leakage by means of a very sensitive Thomson's galvanometer.

Core insulated with gutta-percha.

Duration of electrification in minutes.	Number of measurements.	Ratio of potentials in volts.	
		$\frac{52}{460}$	$\frac{52}{208}$
1	1	4.8 per cent.	...
2	...	5.4 "	...
1	2	4.6 "	...
2	...	5.0 "	...
1	3	10.6 "	2.4 per cent.
2	...	10.9 "	2.3 "
1	4	8.5 "	1.0 "
2	...	6.7 "	...
1	5	6.8 "	...
2	...	7.9 "	...
1	6	6.6 "	...
2	...	8.1 "	...
1	7	5.7 "	...
2	...	6.2 "	...
1	8	5.3 "	...
2	...	6.7 "	...
1	Mean	6.6 per cent.	2.0 per cent.
2		7.1 "	2.2 "

Cable coated with Lead, No. I.

Number of Determinations.	Ratio of potentials in volts.			
	$\frac{52}{460}$	$\frac{52}{208}$	$\frac{21}{460}$	$\frac{21}{208}$
1	3.3 per cent.	0.77 per cent.	...	...
	2.8 "	0.80 "	...	...
2	2.3 "	0.47 "	...	...
	2.0 "	0.56 "	...	...
3	2.4 "	0.47 "	...	...
	2.1 "	0.75 "	...	...
4	...	...	3.3 per cent.	2.4 per cent.
	...	...	3.7 "	2.8 "
5	3.8 "	1.6 "	4.3 "	2.2 "
	3.8 "	2.5 "	3.8 "	2.5 "
Mean	2.9 per cent.	0.81 per cent.	3.8 per cent.	2.3 per cent.
	2.7 "	1.15 "	3.8 "	2.7 "

Cable coated with Lead, No. II.

Number of Determinations.	Ratio of potentials in volts.		
	$\frac{52}{460}$	$\frac{52}{208}$	$\frac{104}{460}$
1	2.2 per cent.	...	...
	9.0 "	...	...
2	8.1 "	4.4 per cent.	6.0 per cent.
	10.0 "	8.1 "	4.4 "
3	...	...	3.6 "
	...	...	5.5 "
4	...	...	3.4 "
	...	...	6.1 "
5	3.5 "	...	2.3 "
	4.1 "	...	...
6	7.5 "	3.0 "	6.0 "
	7.6 "	3.5 "	5.5 "
Mean	5.3 per cent.	3.7 per cent.	4.3 per cent.
	7.7 "	5.8 "	5.4 "

The Thomson's galvanometer carefully insulated was fitted with four shunts of  $\frac{1}{3}$ th,  $\frac{1}{5}$ th,  $\frac{1}{100}$ th,  $\frac{1}{1000}$ th of that of the bobbins of the galvanometer. The resistance boxes forming the shunts were also insulated with great care. The experimental battery consisted of 330 small Callaud elements to which there could be further joined 60 accumulators, giving a total electromotive force of 460—470 volts. These elements had during all the course of the measurements a very constant electromotive force scarcely varying from 1.06 to 1.02 volts

\* *La Lumière Electrique*.

in the lapse of three months. They were also arranged in groups of 10 so that the difference of potential employed in the measurements could be varied at will.

It is known that temperature exerts a great influence on the insulating power of a dielectric. It was, therefore, necessary to effect the measurements as far as possible at a constant temperature, the more so as they require a long time in consequence of the necessity of completely discharging the cable before each observation.

Herr Heim has taken every precaution to satisfy these conditions, either by plunging the cables into water or by surrounding them with a coating which is a poor conductor of heat.

In order to diminish the residue in the cables, the measurements have been effected in general with a time of charging of only one or two minutes. But the duration of the electrification has a very sensible influence upon the insulation; the insulation after a prolonged electrification is the element which it is important to know in cables with a continuous current. Thus Herr Heim in all his series of observations effected each measurement with an electrification lasting 15 minutes.

It must be noted that in every measurement a beginning has been made with low potentials which have then been gradually increased.

The measurements of Herr Heim have given a conclusive result, which appears clearly from the table No. I.

TABLE II.

Nature of Cable.	Difference of potential in volts.	Insulation in megohms.					
		Time of electrification in minutes.					
		1	2	3	5	10	15
Gutta-percha	53	7,500	8,495	9,020	9,536	10,100	10,540
" "	213	7,200	8,250	8,740	9,370	9,950	10,480
" "	470	7,050	7,960	8,420	9,015	9,570	10,000
Leaded, No. 1	21	2,290	2,870	3,530	4,495	6,480	8,215
" "	213	2,185	2,730	3,250	4,280	6,290	7,955
" "	470	2,180	2,720	3,210	4,190	6,090	7,670
Leaded, No. 2	53	14,750	20,200	24,456	29,800	40,500	47,700
" "	213	13,500	19,200	23,200	29,200	38,100	43,950

That is, that the insulation of the cables diminishes with the potential of the current by which they are traversed.

We do not give the values deduced from each measurement for the insulation of the core of the copper insulated with gutta-percha and of the two leaded cables; we shall limit ourselves to sum up the values in percentages of the decrease of insulation for the different increases of potential.

TABLE III.

Cable.	Ratio of potential in volts.	Decrease of insulation per cent.					
		Duration of electrification in minutes.					
		1	2	3	5	10	15
Gutta-percha	53 : 470	6.0	6.3	6.6	5.4	5.3	5.1
" "	53 : 213	4.0	2.9	3.1	1.7	1.5	0.6
Leaded No. 1	21 : 470	4.8	5.2	9.1	6.8	6.0	6.6
" "	21 : 213	4.6	4.9	7.9	4.8	2.9	3.2
Leaded No. 2	53 : 213	8.5	5.0	5.1	2.0	5.9	7.9

Of the values given in Table I., we see that the decrease of insulation for the greatest variation of potential (50 volts to 460 volts) is about 7 per cent. for the core insulated with gutta-percha, 6.5 per cent. for cable No. 1, and 3 to 4 per cent. for cable No. 2.

The results obtained by Herr Heim on the influence of the duration of electrification upon the insulation of the cables are summed up in Tables II. and III. The latter gives in percentages the decrease of insulation along with the increase of the potential.

These values show that the variations of insulation

with potential are the same for short as for long durations. This conclusion shows that in this kind of measurement it is useless to employ considerable durations of charge.

TABLE IV.

Observer.	Difference of potential in volts.	Duration in minutes.					
		1	2	3	5	10	15
Frœlich	?	1.00	1.11	1.15	1.24	1.33	1.37
Heim	53	1.00	1.13	1.20	1.37	1.35	1.40
"	213	1.00	1.14	1.21	1.30	1.38	1.46
"	470	1.00	1.13	1.19	1.28	1.36	1.42

If we take as a unit the insulation of gutta-percha after a minute of electrification, the values of the insulation after 1, 3, 5, 10, 15 minutes are given in Table IV.; the first line refers to the values given by Herr Frœlich in his treatise on electricity. Lastly, the values corresponding to the two leaded cables studied by Herr Heim are summed up in Table V.

TABLE V.

Leaded cables.	Potential in volts.	Duration in minutes.					
		1	2	3	5	10	15
No. 1	21	1.00	1.25	1.54	1.96	2.83	3.59
"	213	1.00	1.25	1.40	1.96	2.88	3.64
"	470	1.00	1.25	1.47	1.92	2.80	3.52
No. 2	51	1.00	1.37	1.66	2.02	2.74	3.24
"	213	1.00	1.42	1.72	2.16	2.82	3.26

All these results have been obtained at a temperature approximately constant. It remains for us to study the influence of temperature upon insulation, an influence which is considerable, but which is accurately known only for gutta-percha. Its determination will be interesting for leaded cables insulated with a compound of resins and paraffins.

TABLE VI.

Time.	Potential in volts.				Temperature.
	2	20	102	400	
h. m.					
3 15	...	6.16	...	...	17.2°
3 36	...	...	3.72	...	
4 23	...	6.53	...	...	
4 47	...	...	...	2.72	
5 46	...	6.68	...	...	17.2°
3 52	17.0	...	...	...	
4 28	...	8.00	...	...	
5 34	17.2	...	...	...	
5 50	...	...	4.66	...	Heat engine
10 42	...	0.75	...	...	
11 35	...	...	0.55	...	
12 35	...	1.01	...	...	
1 3	...	...	...	0.50	Heat engine
4 10	...	0.82	...	...	
4 41	...	...	0.67	...	
5 12	...	1.02	...	...	

We may also mention the measurements which Herr Heim has made on the insulation of the field magnets of a Schuckert machine in derivation. These measurements have been made both in cold and in heat after having passed a current of 2 ampères per square millimetre into the magnets for six hours. The results in megohms are summarised in Table VI., which shows a decided decrease of insulation with the increase of potential, and, besides, how much the insulation measured in heat differs from that which is measured upon the machine in the cold.

These results prove that the measurement of the insulation of a machine should be made when the latter is hot, and with a difference of potential the same as that at which the machine works.

The values in megohms of the insulation with refer-

ence to the earth of two circuits placed along the sides of a hall are shown in Table VII. The circuit, A, was composed of a copper cable of 19 strands of 1·2 millimetre surrounded first with an incombustible ribbon, then with a ribbon saturated with gutta-percha, and then with cotton steeped in tar. This cable was 150 metres in length; it was fixed upon small shelves by means of ordinary hooks. The circuit, B, was common bell wire of 0·9 mm. insulated with cotton soaked in paraffin. It was fixed to the plastered walls by means of common hooks.

TABLE VII.

Potential in volts.	Insulation in megohms.	
	Circuit A.	Circuit B.
2	0·63	0·124
20	0·58	0·091
2	0·61	0·117
120	0·50	0·085
3	0·75	0·111
20	0·57	0·100
2	0·60	0·119

The results of Table VII. show that in a lighting installation where the difference of potential is 100 volts a battery of few elements may serve to verify the insulation of the cables.

Herr Heim concludes his work by submitting the measurements of Fordenreuther to a very thorough criticism. He shows in particular that Fordenreuther has not taken temperature into consideration, and that certain series of measurements which lasted longer than one day are discussed without taking this factor into account.

PROMISING ELECTRICAL PROGRESS.

THE Shakesperian adage about the tide in the affairs of men which taken at the flood leads on to fortune was, perhaps, never more strikingly illustrated than in the case of some of the electrical enterprises of the present day. Amongst the foremost of these is entitled to be placed the firm referred to in the notice boards conspicuously placed on many buildings in the metropolis, stating that the electric lighting is by Rashleigh Phipps and Dawson. The concern was commenced only three years since in a very modest way in premises in Gray's Inn Road, which had the appearance of having been originally put up as stables, but with alteration, made to do duty as workshops. This happened to be just the time when a large demand was springing up for electric lighting, and by laying themselves out to meet the prevailing tastes, the new firm soon found their productions in such request, that they were compelled to take large works and show rooms in a much better, if more highly rented, locality. At No. 53, Berners Street, they have now what we believe is the most extensive manufactory in this country devoted exclusively to the production of fittings for the electric light, though undoubtedly there are larger establishments in which the making of these goods has become an important branch. In Messrs. Rashleigh Phipps and Dawson's show rooms at Berners Street a very fine display is made of fittings to suit every requirement, every one of which is connected up, so that the effect when lighted can be shown in a moment. The originality of many of the designs may perhaps be partly explained by the fact that they have been thought out from the standpoint of the electrician, and are thus free from the mannerisms sometimes observable in the work of men who have been a lifetime engaged in designing fittings for gas. By means of a staff of artists and designers, special patterns, when required, are produced to harmonise with any particular style of decoration or furniture.

The firm has just issued a catalogue of electric light

fittings, handsomely printed in colours, giving a good idea of the style and appearance of a considerable number of these articles. It is, however, pointed out in the preface that it has not been thought advisable to include in the book some of the best and most elaborate patterns. The publication, indeed, seems intended more as an invitation to those interested to visit the show rooms, where illustrations will be found in sufficient variety of style to meet every taste and requirement. A matter to which considerable attention is given is that of lamp shades, the prevailing material employed for these being silk. A very pretty and striking lamp shade is afforded by mother-o'-pearl shells, the effect of which may be seen in a newly-opened bookseller's shop at the corner of Berwick Street and Oxford Street, where the lamps have been fitted with such shades.

The manufacture of fittings has developed so rapidly, that the present workshops in Berners Street are already found to be too small, and additional room is being made, by excavating below the premises, for sixty additional lathes and an extra engine.

The making of fittings is, however, only a subordinate part of the business of the firm, which embraces the supply of every requisite for the electric light, and the carrying out of all the needful work involved in its installation. As a matter of history, it may be mentioned that six years ago, or more, Mr. Rashleigh Phipps fitted up what was almost the first domestic installation in London using a gas engine and accumulators. This, we understand, has been running almost without a day's cessation up to the present moment. The first year or two we were supplied with figures, which we published at the time, showing the cost of maintenance of this interesting experimental installation. Since that time some of the most important work in the metropolis has been put into the hands of this firm, such, for instance, as the lighting of the Garrick Theatre with about 1,000 lights, said to be the most artistically-lighted theatre in London; the new Tivoli Theatre and Restaurant, which are also beautifully lighted, the fittings for which were designed and manufactured within two weeks from the date of order; and, more recently, the Standard Music Hall, where between 300 and 400 lights have been put in. Amongst large installations of a more private though not less important nature which have been carried out by the firm may be mentioned the new mansion of Mr. Robert Harrison, Shiplake Court (300 lights with duplicate plant); Mr. Warren De la Rue's house, Newmarket (200 lights with steam plant and accumulators); and Messrs. Marshall and Snelgrove's, Oxford Street (complete plant). The firm have compiled and published a list of recent installations, consisting of no less than 74 private houses and 20 houses in which complete plant with accumulators has been installed.

The firm pride themselves on their promptness. The Architectural Association gave a *conversazione* on the evening of the 3rd inst., at the Westminster Town Hall, on which occasion the whole of the rooms were brilliantly lighted, the lamps and shades assuming many different forms and colours, some of them exceedingly artistic. The lighting was carried out by Messrs. Rashleigh Phipps and Dawson, the current being supplied specially by the Westminster Electric Supply Corporation. Owing to this arrangement, even when the rooms were most crowded, the air was tolerably cool. The whole of the work connected with this temporary installation was completed in three days.

Enough has been said to show that whatever others may do, the firm to whom reference is here made are determined to take their tide of prosperity at the flood, and we hope it will lead them safely on to fortune.

A most diversified catalogue of electric light fittings has just been issued by Messrs. B. Verity and Sons. It was, we understand, got up in Paris, and it can be seen at a glance that no expense has been spared in its preparation. It consists of 48 large sheets, each consisting of a number of patterns, including pendants, brackets, electroliers, standards, and every other form in which such articles are made. Nearly every pattern illus-

trated is kept on view in the showrooms of the firm at King Street, Covent Garden, and Regent Street, and the same pattern can be supplied in polished brass, bronze, nickel silvered, or electro silvered. At the show rooms there are also replicas of many of the finest examples of French and Italian girandoles, &c., in mercury gilt, any of which can be fitted for electric light. The price list contains a notice that Messrs. B. Verity and Sons have in preparation a catalogue of electrical sundries, in which particulars will be given of the "Verity patent quick make and quick break" switch, and the "Verity patent safety cut-out," by the use of which it is impossible to fix a large fuse into a block intended for a smaller size. The firm is devoting a large amount of attention to the designing and making of good

## IMPROVEMENTS IN TELEPHONE EXCHANGE SWITCHBOARDS.

THE switchboard in every telephone exchange forms perhaps the most important part of any of the requirements. For all large exchanges of over 400 subscribers the well-known multiple boards are principally used in this as well as in other countries. They have from time to time been subject to much attention and many improvements, while the switchboards for all small exchanges have been comparatively neglected, and many of the oldest and worst type are still at work. We therefore have much pleasure in giving particulars which have been furnished us relating to the switchboard shown by figs. 1 and 2.

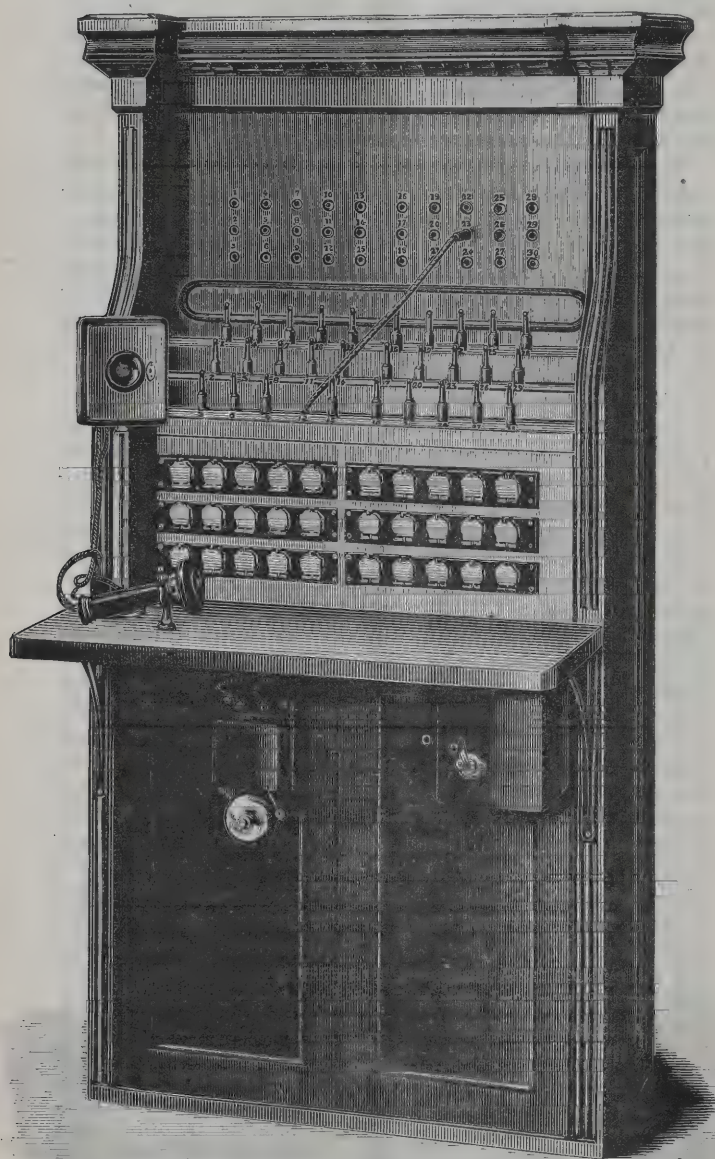


FIG. 1.

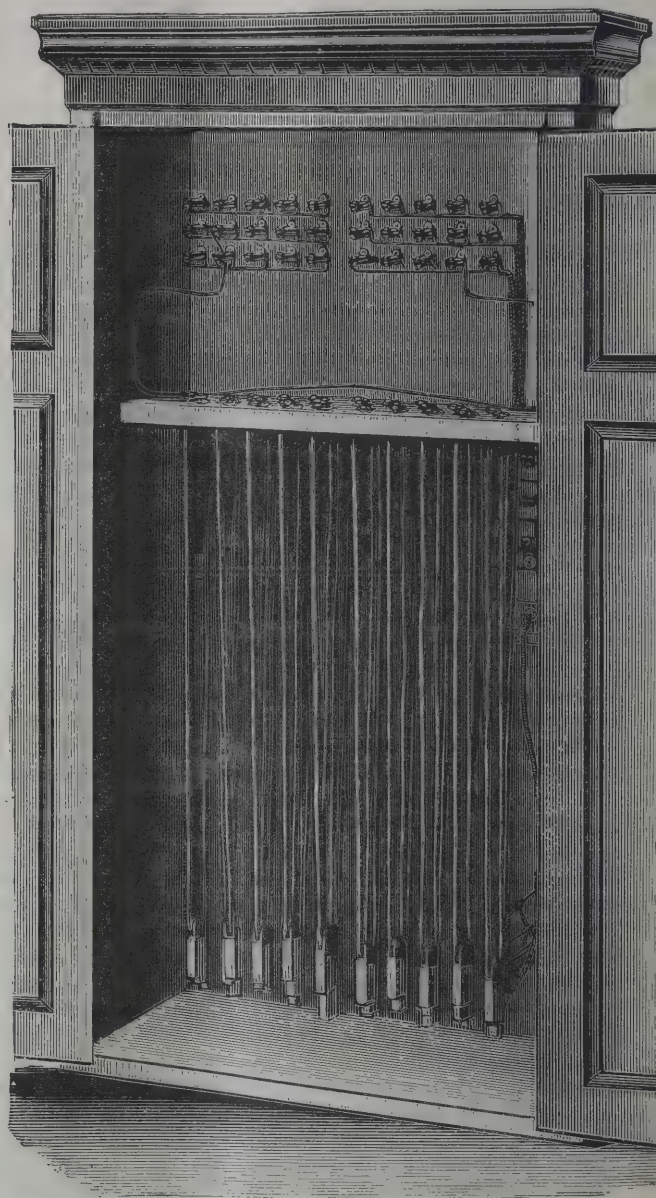


FIG. 2.

switches, switchboards, resistance frames, battery cut-outs, wall attachments, and such like accessories. High-class switch covers in Louis XIV. and other French styles, finished in gold, silver, or bronze, are specially treated, to suit the ornamentation of rooms. We are not surprised to learn that the vast expansion of Messrs. Verity's business through the prominent position they have taken in the electric lighting industry has necessitated their establishing a factory at Birmingham.

**The Electric Light in Brussels.**—In a few days from now the authorities of Brussels will open a competition for a model of the Venetian masts (to which we referred last week) intended to support the electric lighting apparatus in the Grand Place.

These switchboards are known as single-cord boards. They were designed by Mr. D. Sinclair (late engineer for the Glasgow district and now the London manager of the National Telephone Company), and were manufactured by the Telegraph Manufacturing Company, Helsby.

The particular board shown by figs. 1 and 2 (fig. 1 being a front, and fig. 2 a back view showing the cord pulley weights), is fitted for 30 lines, this being a standard pattern for any number of lines from 25 up to 150.

The electrical connections, as shown by fig. 3, are of the very simplest nature, and are so arranged as to give the best electrical and mechanical condition when any two lines are joined together with the least possible

amount of work to the operator.  $L^1, L^2, L^3$ , represent three subscriber's lines led into the exchange.  $J^1, J^2, J^3$ , are the jacks,  $I^1, I^2, I^3$ , the indicators  $C^1, C^2, C^3$ , the wire cords,  $P^1, P^2, P^3$ , the terminal plugs and  $T$  the operator's table. A connecting wire cord with a single plug is permanently attached to each line led into the switch-board in the exchange, and when one subscriber, as, for example, Number 1, is to be connected to another, *e.g.*, Number 2, the operator, inserts the plug,  $P^1$ , constituting the terminal of Number 1 subscriber's line into the jack,  $J^2$ , in the line of subscriber Number 2, thereby also cutting the second subscriber's indicator,  $I^2$ , and earth out of the line to which connection has been made, whilst leaving in circuit the indicator,  $I^1$ , of the line whose terminal plug,  $P^1$ , has been used.

It will be seen that there is the usual line jack and indicator for each line, but instead of the line in the ordinary way going direct to earth after passing through the indicator, it goes, as shown, to a cord, and finds earth at the plug, the latter being placed normally in contact with earth terminals at  $t$  on the table,  $T$ . In this way, there is a cord and plug for each line on the board, and as one end of the cord is permanently

perfectly well for all telephone lines of the ordinary length.

The operating of the board is as follows: say No. 5 wishes any one he rings, his indicator drops, and the operator inserts her general operating plug into the line jack, and receives instructions. If No. 10 is asked for, the operator removes general plug into that No. and rings. When No. 10 replies, the plug of No. 10 line is inserted into jack of No. 5 line, and so the connection is complete. Operator generally waits with her plug tapped on until the two parties are heard in communication. When the conversation is finished, either one or both ring off (it ought to be the party who first applied, but it is difficult to get subscribers to work to any rule), and the operator disconnects the plug, which automatically finds its way back to rest and earth by the ordinary pulley and weight arrangement.

This operation, as compared with the old system, where there were no special keys and cords used, saves about 50 per cent. of the operator's work, and as compared with the system of providing special keys and cords, about 30 per cent. of the operator's work. It is likewise a great advantage on a busy board to have only

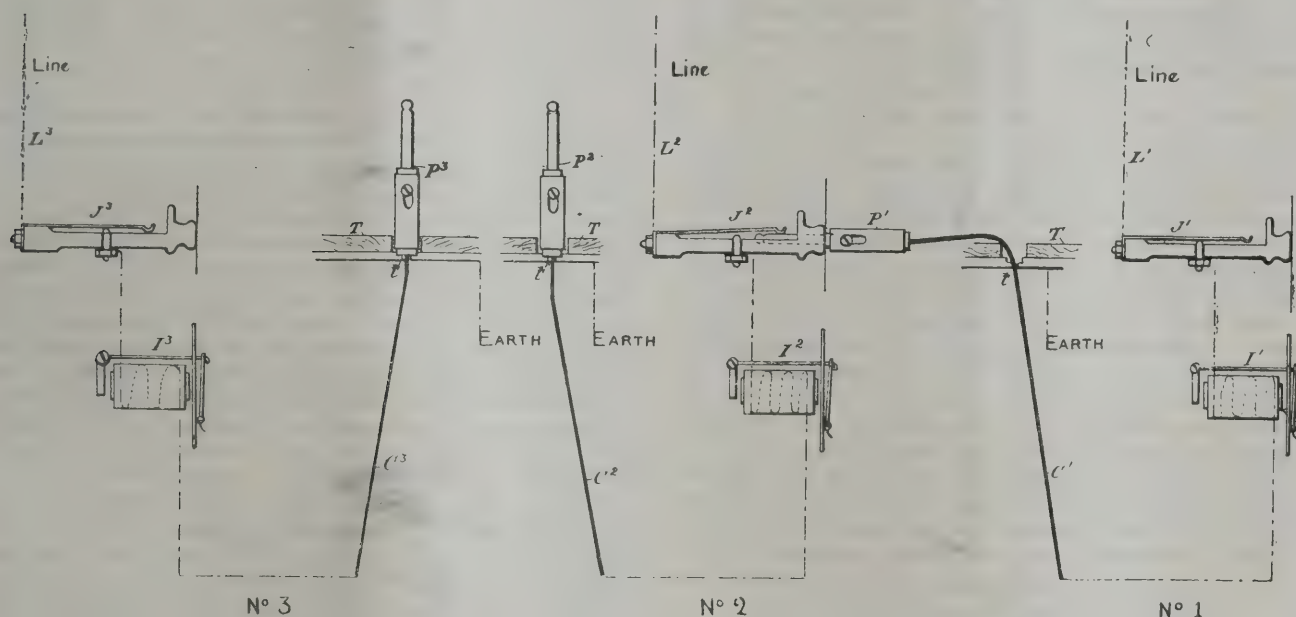


FIG. 3.

attached to the line, it only requires (as has been explained) for the plug of any line to be inserted into the line jack of any other line to make connection between the two, while if a loose cord, with a plug on each end of it is used, as in ordinary small switchboards, it is plain that much more work is necessary in making a connection. Lifting the plug of any line disconnects it from the earth, leaving the indicator in circuit, so that when the plug is inserted into the jack of any other line, this indicator acts as a "ring off" indicator, and the act of inserting it cuts off the indicator cord and plug of the line inserted, so that only *one* indicator is in circuit when any two lines are joined together.

In the old boards both indicators were left in circuit, or they were both cut off, left idle, and a special ring-off indicator provided in the cord circuit; but this was hardly ever carried out in practice on small boards. On the old boards, indicators were wound to a resistance of about 80 ohms, so that with two in circuit the resistance to stable measurement was 160 ohms, which, with the amount of self-induction and retardation, produce very bad effects upon the communication. The indicators adopted in these boards are somewhat of the old type, but joined up in parallel, so that the ordinary resistance is about 20 ohms. These are found to act

one half the number of cords to deal with, as it prevents any confusion to a great extent.

This system was first introduced about three years ago, and it is now extensively used in this country, and continues to grow in favour. Several switchboards of this kind have been supplied for use abroad, and have given much satisfaction.

## SOME NOTES ON OVERHEAD LINES.

By STUART A. RUSSELL.

THE purpose with which these notes have been written is not to discuss the general question of overhead lines, but rather to direct particular attention to that part of the subject which deals with the mechanical strains which they have to withstand; and to compare the present practice as regards overhead electric light and telegraph lines with the regulations for the construction of the former which have been issued by the Board of Trade.

Having recently had occasion to work out the particulars of an overhead line, I was somewhat

astonished to find that the Board of Trade regulations required it to be so much stronger and heavier than has been previously considered necessary; and it appeared to me to be worth while to draw attention to the comparison mentioned above, in the hope that others, who are interested in this matter, would be able, by quoting their experience, to bring together a mass of practical information which would help in the drawing up of a specification which, whilst providing for a perfectly safe line, would not entail needless expense on its construction.

The chief reason of the increased weight of the line is to be found in Section 29 of the regulations\*, which specifies for a wind pressure of 50 lbs. per square foot, and a factor of safety of six for the suspended wire, and of twelve for all other parts of the line; whereas previous practice has assigned a much smaller value to the wind pressure, and has generally used a factor of safety of four. Here I may mention with regard to wind pressure, that there seems to be considerable doubt as to what is the actual effective pressure on a suspended wire; no reliable experiments on the subject have been made and published so far as I can find; and values varying from 0.5 to 0.75 are given by different writers to the coefficient, by which the pressure exerted on a plane surface perpendicular to the direction of the wind has to be multiplied to get the corresponding pressure on a suspended wire. The value I have given to this coefficient is 0.6, thus making

$$\text{the pressure on the wire per foot run } P_1 = \frac{0.6 \times P \times d}{12}$$

= .05 P d, where P is the pressure per square foot on a plane surface, and d is the diameter of the wire in inches. For comparison, the particulars of several lines are given in Tables I. and II.; the former being for lines erected in accordance with Board of Trade regulations, and the latter for lines such as would be erected in accordance with what I believe has been usual practice. In both cases the cables are insulated with vulcanised India-rubber to the thickness specified by the Board of Trade, and then taped and braided; the suspension wires are of stranded steel, and the span and dip are respectively 200 feet and 5 feet.

These tables show how considerable is the increase required by the Board of Trade in the size of the suspension wires, and if we now suppose such lines erected on the housetops, and calculate out the strains on the

supports, we shall find that it will be necessary to provide saddles long enough to take a bearing on two or more roof principals, and that the difficulty of finding good anchorage for the stay wires will be very considerable; indeed, in some cases, it might even be necessary to rebuild a great part of the top of the house before it would be strong enough to bear the strain. It must here be borne in mind that the factor of safety for the supports is 12, and if this is to be applied to the roof of the house as part of the support, I am afraid we shall not be able to find many that will satisfy the specified conditions. Tables I. a and II. a give the strains on the supports and size of stay wires for double conductor lines of 7/20 and 19/15 cables; the former for a wind pressure of 50 lbs. per square foot and a factor of safety of 12; and the latter for a wind pressure of 20 lbs. per square foot, and a factor of safety of 6.

Size of conductor.	Side strain at point of support.	Strain in stay wire at angle 45°.	Size of stay wire.	Vertical component of strain in stay wire.	Weight of line.	Total pressure on roof.	
7/20	778	1,104	19/14	778	150	1,150	Table I. a.
19/15	1,130	1,598	19/13	1,130	363	1,750	
17/20	235	332	7/18	235	67	450	Table II. a.
9/15	355	502	7/16	355	227	750	

Coming now to the consideration of overhead telegraph lines, I propose to compare some data concerning the Post Office lines given by Mr. Preece, in two papers read before the British Association, with the regulations of the Board of Trade; and to point out the modifications which would have to be made in Mr. Preece's figures, before the practice of the one Government Department would conform to the demands of the other. The paper read at the 1887 meeting gives a table of spans, dips, and strains, at various temperatures for the three wires most used by the Post Office; and also states that a factor of safety of 4 is allowed for all wires at minimum temperature, and that the calculations have

been made from the formula  $d = \frac{a^2 w}{8t}$  where "w" is the weight of one foot of the wire. In Table III., a part of Mr. Preece's table is reproduced; and, for comparison, the length of span  $a^1$  is given in each case which would correspond to the same dip, if the permissible strain in the wire  $t^1$ , and the resultant pressure

\* See ELECTRICAL REVIEW, 17th October, p. 461.

TABLE I.—Wind pressure, 50 lbs. per square foot. Factor of safety 6.

Insulated cable.				Suspension wire.					
Copper strand.	Outside diameter.	Weight per foot run.	Wind pressure per foot run.	Steel strand.	Diameter.	Weight per foot run.	Wind pressure per foot run.	Safe working tension.	Strain at insulator.
7/20	.418	.108	1.045	19/15	.360	.268	.900	1,970	1,980
7/18	.454	.141	1.135	19/14	.400	.331	1.00	2,430	2,190
7/16	.502	.195	1.255	19/14	.400	.331	1.00	2,430	2,320
19/18	.550	.257	1.375	19/14	.400	.331	1.00	2,430	2,440
19/16	.630	.385	1.575	19/13	.460	.437	1.15	3,200	2,850
19/15	.670	.470	1.675	19/13	.460	.437	1.15	3,200	2,970

TABLE II.—Wind pressure, 20 lbs. per square foot. Factor of safety 4.

Insulated cable.				Suspension wire.					
Copper strand.	Outside diameter.	Weight per foot run.	Wind pressure per foot run.	Steel strand.	Diameter.	Weight per foot run.	Wind pressure per foot run.	Safe working tension.	Strain at insulator.
7/20	.418	.108	.418	7/17	.168	.059	.168	650	610
7/18	.454	.141	.454	7/16	.192	.077	.192	850	682
7/16	.502	.195	.502	7/16	.192	.077	.192	850	746
19/18	.550	.257	.550	7/16	.192	.077	.192	850	814
19/16	.630	.385	.630	7/15	.216	.098	.216	1,080	974
19/15	.670	.470	.670	7/15	.216	.098	.216	1,080	1,050

per foot run  $w^1$  are calculated to Board of Trade specification ; i.e., if  $w^1 = \sqrt{w^2 + (2.5 d)^2}$  and  $l^1 = \frac{2 l}{3}$

TABLE III.

	d.	w.	l.	a.	$w^1$ .	$l^1$ .	$a^1$ .
No. 7½ iron wire..	3.15	.076	270	300	432	180	102
„ „ „ ..	1.14	.076	270	180	432	180	62
No. 12½ hard drawn copper ... ..	2.66 0.97	.028 .028	120 120	300 180	246 246	80 80	84 50
No. 14 hard drawn copper ... ..	2.66 0.97	.019 .019	80 80	300 180	201 201	54 54	76 46

From this it will be seen that the Board of Trade would require from three to four times as many poles to be used according to the size of wire ; a change which would add considerably to the cost ; and would, by increasing the number of insulators, seriously diminish the insulation resistance of the line. Of course the number of poles need not be increased to such an extent if a greater dip is allowed ; but a limiting maximum dip is soon reached in lines carrying several wires, owing to the increased danger of contacts when the wires are swayed by the wind ; and even a dip of 10 feet would only allow of a span of 180 feet for the iron wire, and of 142 feet for the No. 14 copper wire.

Mr. Preece's other paper, which was read at the 1885 meeting, deals with the strength of wooden poles, and gives some very valuable experimental results obtained at the Gloucester Road factory, concluding with two tables giving the safe diameters of poles for 60-yard spans of 17 and 20 wire lines, calculated for a wind pressure of 18.75 lbs. per square foot with a coefficient of 0.6 and a factor of safety of four. Comparing these figures (which, it may be noted, Mr. Preece says are well confirmed by the results of practice) with those specified by the Board of Trade, it will be seen that the wind pressure in the latter case is  $2\frac{2}{3}$  times that in the former ; and therefore for lines which are otherwise similar, the moment of pressure on the pole will be increased in the same proportion. Since, however, the Board of Trade factor of safety is 12, or three times that used by Mr. Preece, the actual strength of the poles must be as 8 to 1, which means, if they are of circular section, that their diameters must be as 2 to 1. If the length of span is reduced as in Table III., there will be from 3 to 4 times as many poles required, each of which will need to be from  $2\frac{2}{3}$ rd to 2 times as strong as those given by Mr. Preece for his longer spans.

A consideration of the results given above naturally leads to the question, are all the Post Office lines and all the electric lines absolutely unsafe, or are the present regulations of the Board of Trade unnecessarily stringent ? The answering of the first part of this question, so far as it relates to the telegraph lines, may well be left to the engineers of the Post Office, who have the experience of many years to guide them ; and, with regard to the electric light lines, I believe I am correct in saying that, in London at any rate, no accident has happened through mechanical weakness, although some of them were exposed to the storm of December 26th, 1886, which played such havoc with many of the overhead lines throughout the country. From these facts I can only come to the conclusion that the Board of Trade regulations are needlessly stringent, and that if they are enforced they will be the cause of a considerable useless expenditure of money ; so much so, indeed, that the regulations might almost as well forbid the use of overhead lines at all, as their cost will be so nearly equal to that of putting the cables underground. As an advocate of underground work whenever possible, I am generally glad to welcome everything which will increase the use of subterranean cables ; but, at the same time, I cannot but regret any unnecessary increase in the cost of overhead wires, seeing that they may do

such excellent service in opening up new districts, which, from the small number or scattered positions of their lights, are practically shut out from all chance of an electric service by underground cables ; and for this reason I would be glad to see an alteration in the Board of Trade regulations, which, while providing for a perfectly safe line, would yet allow of that line being erected at a moderate cost.

THE SARDINIA STREET STATION.

THE largest station of the Metropolitan Electric Supply Company is situated in Sardinia Street, at the side of Lincoln's Inn Fields, W.C., and is the first to be carried out in so far as the internal arrangements are concerned, by the English Westinghouse Electric Company on its well-known system. The erection of the station was commenced in the early part of 1889, and the building was completed just over a year ago. At the time, however, only half of the generating plant was installed, but now the whole of the machinery is in position and the station may be considered as practically complete. The station occupies a large area of ground, and has recently been increased in size by the acquisition of an adjoining building which was formerly used by a basket maker, and which is now utilised partly as a storeroom and partly for housing a portion of the staff.

There are two entrances in Sardinia Street, one giving access through the offices to the south side of the station, and the other being a cart entrance for coal waggons to pass into a large shed. Underneath this shed is a large vault capable of containing 500 tons of coal, which is shot down through trap-doors. On the eastern side of the shed is situated the fuse room, a large oil room and a store room for engine and dynamo bearings, bolts, and other replaceable parts of the machines. The station itself, which is a two storeyed building, is on the western side of the shed, and the boiler house forms a separate building on the north of the station. This house contains a battery of twelve Babcock and Wilcox boilers, five being erected on one and seven on the other side. They are each of about 210 H.P., are all connected together by a ring of steam piping, and work at a pressure of 150 lbs. There are three Worthington pumps which supply water to three feed-water heaters of the Babcock and Wilcox type. A fan is in course of erection so as to allow of the use of forced draught in order to get up steam quickly, as for instance on a fog suddenly occurring. In the middle, and throughout the length of the boiler house, is laid a narrow gauge tramway for coal trolleys, the rails terminating inside the large vault already mentioned. Thus the coal can easily be conveyed to the boiler furnaces.

The engine room occupies the ground floor of the station, and is very spacious and lofty. A wide central passage has been arranged longitudinally, and on either side are erected five Westinghouse compound engines. Of these 10 machines, five are of 250 H.P. each running at 280 revolutions, whilst the remaining five are of 300 H.P. each and make 250 revolutions a minute. These engines are the largest of the Westinghouse type yet introduced into this country. In addition to these, there are installed in one corner of the engine house three smaller engines of 65 H.P. each, the speed being 300 revolutions. These three engines actuate the exciters. Steam is supplied from a main steam pipe, asbestos jointed, arranged in the form of a ring, suitable branch pipes being conveniently led off. The foundations for all the engines are very well and solidly constructed, being composed of concrete and brickwork. From the large flywheels the belts pass up overhead at an angle of about 30° through belt holes into the dynamo room on the upper floor. The latter is an equally spacious and lofty room containing 10 Westinghouse alternators running at 1,050 revolutions, and having an output of 125 kilowatts each, the pressure being 1,000 volts. The three exciting dynamos, which are also of the Westinghouse type, run at 900

revolutions with an output of 300 amperes at 100 volts, and any one is sufficient to excite the field magnets of six alternators.

The switchboard is a very complete and elaborate arrangement. It is mounted upon panels of polished block slate along one side of the room, with a space of about 30 inches left behind for connections. All the wires to switches, cut-outs, resistance frames, &c., here converge, the instruments for each machine being placed on polished mahogany boards one above the other, with the switches within easy reach, giving ready manipulation and inspection. The switchboard can properly be divided into three distinct parts; first, the exciter switchboard; second, the alternating current dynamo switchboard; and third, the distributing circuit switchboard. Each exciter is operated from the first-mentioned portion of the board, and is entirely controlled by the apparatus there. The latter consists of three rheostats which are in the field circuits of each exciter, the three main exciter switches and the multiple arcing switches for throwing the three exciters together. This is usually done only on changing over from one machine to the other. The second portion, or alternating current dynamo switchboard, consists of two single pole switches for each dynamo, one double pole exciter switch for each dynamo, one ammeter and one field rheostat. By throwing in the main dynamo switch, the operator simply connects the dynamo to two trunk line wires running on the back of the board from end to end. There is a corresponding set of wires for each of the alternating current machines, and it is impossible by any manipulation of the switches on the dynamo switchboard to throw two dynamos in parallel or to short-circuit one dynamo through another, should one be standing still, and the other running at its full E.M.F.

The third portion of the board consists of a dynamo changing switch, a complete set of plugs for cross connecting any dynamo to this particular switch, an ammeter, compensator, and a voltmeter for each of 20 circuits.

There is also in each of the distributing circuits a transformer which is used simply to furnish a secondary current to the circuit voltmeters. The latter reads at 100 volts when the high tension current is at 1,000, the ratio of conversion being ten to one.

Each of these main distributing circuits has also a compensator in the voltmeter circuit. This compensator is set to allow for a certain percentage of drop, whatever it may be, on the line, and by its action on the voltmeter circuit, the reading of the instrument (which is zero reading), is affected in proportion as the load comes on the circuit. Consequently it is only necessary to alter the rheostat in either the main exciter circuit or field circuit of the individual machine, in order to bring the needles back to the zero point, thus allowing for the drop in E.M.F. on the distribution circuit.

From the switchboard proper in the station, the twenty circuits from the corresponding number of distribution circuit switches are led to the fuse house across the yard. The twenty circuits are again subdivided as necessity demands. In some cases one of the twenty main distribution circuits will be divided again into six, or the entire current from one of these main circuits may be taken out by one cable. The object has been to subdivide the lighting circuits as much as possible, but up to the present no necessity for this subdivision has arisen, other than that due to shutting off the current in order to connect a new subscriber. Each of the fuse boards in this house consists of six single pole switches, and six fuses of the Wurts patent. These while quite open, absolutely prevent any chance of an arc being produced between the binding posts, if by any means the external line should become short circuited. Each circuit is labelled with the name of the street in which the cable is laid, and any circuit can be cut out as desired. These cables are then carried into a cellar underground where the street mains are brought in. The fuse room is fitted with an elaborate set of testing apparatus.

The cables employed by the company are of the well known Silvertown type, the largest size used being 37/16, and the smallest, 7/16. The conduits consist of iron pipes, cast vertically, and ranging from 3 inches to 5 inches in diameter. They are partly laid under the footpath, near the kerbstone, and partly under the carriage way. In some cases, owing to the existence of high cellar arches, &c., the conduits have had to be laid so that their upper surfaces are almost in contact with the flagstones. Junction boxes have been provided at suitable intervals, and the house connections are made by means of loops, no T joints being used except in Lincoln's Inn Fields, where mains were first laid.

On each consumer's premises are installed a Shallenberger meter, which type, it will be remembered, has come into extensive use in the United States; a Westinghouse converter, and a main switch. The interior wiring has to be effected by consumers under the regulations of the company, and those laid down by the Board of Trade.

The mains are laid in rings so as to minimise the danger of extinguishing a number of lights in case of a breakdown. All the stations of the Metropolitan Company are connected together by trunk mains, so that one station may take over the load of the other or a portion thereof if necessary.

Customers are usually charged for light by meter at the rate of  $7\frac{1}{2}$  per Board of Trade unit, which is equivalent to  $\frac{1}{4}$ d. per eight candle-power lamp per hour; but a fixed rate per lamp per annum may be arranged. For instance, the charge for an eight C.P. lamp, burning on an average three hours daily, is £1 per annum. The company's other charges which are for annual rent of transformer, main switch and meter, are as follows: transformer, £1 per annum for every 50 eight C.P. lamp, or a less number; main switch, 7s. 6d. per annum, and meter, £1 per annum. The total cost is thus brought up to 8d. per Board of Trade unit. The station buildings were designed by Mr. Robert Walker, A.R.I.B.A., and Mr. Frank Bailey, A.M.I.C.E., is the engineer to the company.

### EFFICIENCY OF THE EDISON-HOPKINSON DYNAMO AND WILLANS CENTRAL VALVE ENGINE.

VARIOUS tests have been published from time to time of the efficiency of Messrs. Willans and Robinson's central valve engine, and the various types of dynamos with which they are combined. At a recent test made at Thames Ditton with a large Edison-Hopkinson dynamo, constructed by Messrs. Mather and Platt, of the Salford Ironworks, Manchester, a result has been obtained giving an efficiency superior to anything previously attained.

The results show an efficiency of engine and dynamo combined, *i.e.*, the ratio of the electrical power available for useful work outside the dynamo to the indicated power of the engine of 86.7 per cent.

The following are the particulars of the engine and dynamo:—Compound double-crank engine with low pressure cylinders, 14 inches diameter, stroke 6 feet, to work with 120 lbs. steam pressure, driving direct an Edison-Hopkinson dynamo, constructed for an output of 110 volts, 475 amperes, at 430 revolutions per minute. The dynamo has a bar armature (patent No. 4,884, 1886, John Platt, John Hopkinson, and Edward Hopkinson), and is shunt wound only, and is fitted with a commutator of hard drawn copper, with mica insulation, with four brushes on each rocking arm.

Resistance of magnets ... 16 ohms.

Resistance of armature ... 0.0055 "

I.H.P. ... 83.3

E.H.P. ... 72.2

Hence efficiency 86.7 per cent.

Consumption of water per I.H.P. hour ... 21.6 lbs.

" " " " E.H.P. hour ... 25 lbs.

In the tests made on this combination, both engine and dynamo were worked to a somewhat higher load than their normal or specified load, and this no doubt would to a slight extent favourably affect the efficiency. Another test was made on a similar combination working at its normal load, with the following results :—

Resistance of armature ... 0.0058 ohms.  
Resistance of magnets ... 15.6 ohms.

I.H.P. ... 85.3

E.H.P. ... 70.0

Hence efficiency ... 83.3 per cent.

The electrical losses in the first instance are :—

Loss in magnet coils ... 756 watts = 1.4 per cent.

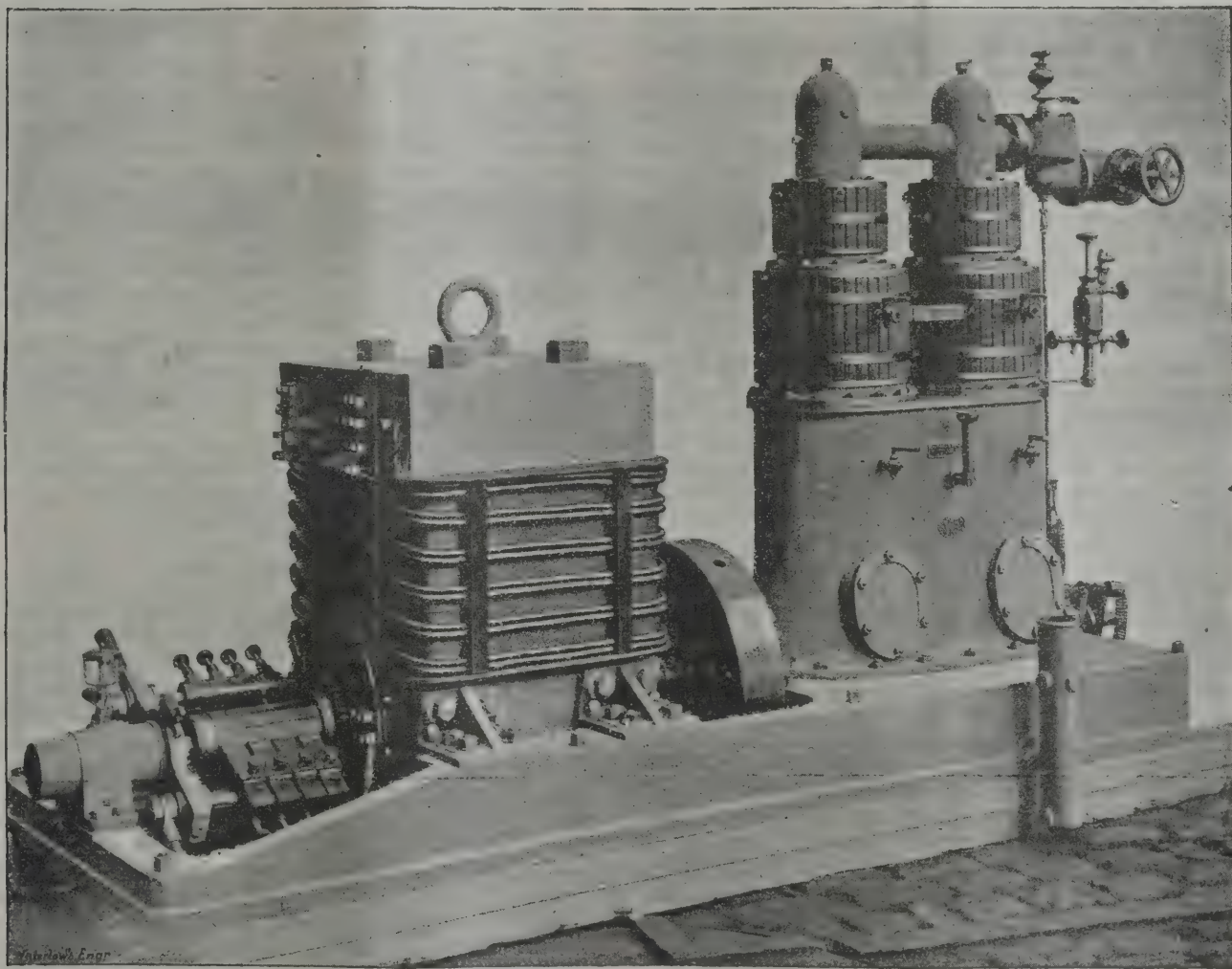
Loss in armature ... 1,386 watts = 2.6 "

Hence electrical efficiency ... 96.0 per cent.

### THE NEW WEST INDIA CABLES.

THE SS. *Westmeath*, chartered for the laying of the new cables which are to connect certain of the West India islands with various points on the continent of South America, left Messrs. Henley's works at North Woolwich on October 15th.

It will be remembered that the *Westmeath* was employed for the laying of the Bermuda-Halifax cable, and on that occasion she was fitted with cable machinery and tanks, which, with some modifications, have been retained as originally designed. The vessel was built at Sunderland in 1882, is classed A-1 at Lloyds, her carrying capacity is 4,400 tons, her length 320 feet, beam 42.4 feet, depth of hold 28 feet, and H.P. 300 nominal. She is said to be a very comfortable boat, extremely steady in a sea way, and possessing unusually good accommodation.



From this it follows that the loss in friction in the engine and dynamo combined is 10 per cent.\* of the indicated horse-power.

Messrs. Mather and Platt have constructed a large number of dynamos for combination with the Willans engine. Those referred to above are part of a number constructed to the order of Mr. Hargreaves for the City installations of Messrs. Spiers and Pond. Others of a considerably larger output are in progress for Messrs. Gatti's central station in the Strand, and for the Westminster Electric Supply Corporation, Limited, installations.

**City Electric Lighting.**—We beg to call the attention of electric lighting contractors to the advertisement in our business columns emanating from the City Commissioners of Sewers with regard to the City lighting.

A large party met on board the ship at Greenhithe, on October 16th. Among those present were—M. Jules Lair, president; M. Paul Wallerstein, general administrator; and M. Ernest Vlasto, director and manager of works of the French Telephone Company. The works company was represented by Mr. Sutton, general manager, and Mr. Hatton, manager of works. Among the actual members of the expedition are Mr. W. S. Seaton, to whom is entrusted the entire direction of the work; Mr. Theophilus Smith, chief of staff; Mr. E. W. Stallibrass, engineer; and Mr. Hall, of Messrs. Henley's, chief electrician.

The total complement on board amounts to 106 persons, viz.:—Staff, officers, and engineers, 22; cable hands and mechanics, 40; crew, stewards, &c., 26; firemen, &c., 13; representatives of the Telephone Company and passengers, 5.

The cable taken out, 1,021 nautical miles weighing 2,558 tons, was manufactured by Messrs. Henley's or the

\* How is this percentage arrived at?—EDS. ELEC. REV.

Société Française des Télégraphes Sous-Marins, who are also the proprietors of the cables laid, by the *Roddam* in 1888, between Cuba, Hayti, Santo Domingo, Curaçao, and Venezuela. A portion of the core was made by the French Telephone Company in their works at Bezons; it was shipped to England, and sheathed at Henley's.

The types of cable and their respective weights per nautical mile are as follows:—Shore end, 8.6 tons; heavy intermediate, 6.05 tons; light intermediate, 3.75 tons; and main cable, 1.72 tons. The core is composed of 130 lbs. of copper (seven strand) and 150 lbs. of gutta-percha per nautical mile.

The sections to be laid on the present expedition are:—

1. Island of Martinique to Paramaribo (Dutch Guiana). Approximate length about 685 N.M.

2. Paramaribo towards Cayenne (French Guiana). This section will not be completed on the present occasion. So much cable as can be devoted to this section will be laid, the end buoyed, and cable completed on the next trip.

3. Mole St. Nicolas, Hayti, to Port-au-Prince, Hayti. Approximate length about 106 N.M.

The sections to be laid on one or more subsequent expeditions are:—

1. Completion of section between Paramaribo (Dutch Guiana) and Cayenne (French Guiana). Approximate length about 252 N.M.

2. Cayenne to Vizeu, Brazil. Approximate length about 575 N.M.

3. Puerto Plata, Island of Santo Domingo, to Island of Martinique. Approximate length about 670 N.M.

The total length of the new cables, including stock, will be somewhere about 2,500 N.M.

It will be remarked that the new cables will place the system owned by the Société Française des Télégraphes Sous-Marins, in direct communication with the Brazilian land lines at Vizeu. The company will thus have at one extremity (Santiago de Cuba) of their system communication with Europe *via* the cables of the Cuba Submarine Company, and at the other terminal (Vizeu) communication with the whole of the Brazilian Telegraph system.

It must be a source of considerable gratification, not only to the French telegraph and telephone companies, but also to the management of Messrs. Henley's, that the disasters, financial and otherwise, at one time freely predicted, have, at all events up to the present, been completely falsified. The French Telephone Company has evidently made considerable preparations for the extending its operations, for the new cable-sheathing works at Calais are not far off completion. It is expected that a good many orders will be received from the French Government. One drawback is, however, present in the manufacture of sheathed cables, in that the core is made at Bezons, and has to be transported to Calais to receive the sheathing. There is certainly but little difficulty in this transport, since a complete system of canals furnishes a cheap and ready method.

### THE BREWERS' EXHIBITION AT THE AGRICULTURAL HALL.

THERE is not, as a rule, much attraction for electrical engineers at this class of show, and the present exhibition is much on a par with those that have preceded it. With the exception of the exhibits of five manufacturers of gas engines, and two small installations of the electric light, we did not observe any apparatus calculated to interest the electrical fraternity. But it is the duty of an electrical engineer to understand what he should avoid bringing his person in contact with, and notwithstanding there are no line wires to speak of at the Islington show, there are many temptations to sample liquid concoctions, which, in the form presented to the taster, are doubtless as deadly as any live wire

conveying a high potential current. Two of the most dangerous of these abominations are to be specially guarded against, the one a brand new Irish whiskey, mechanically given the age of 10 years in about 10 minutes; to the taste bearing more resemblance to the fires proceeding from the abysmal depths than to genuine matured Jameson or Roe. The other bears the outward appellation of claret cup essence, but, in reality, is nearer akin to vitriol than to a pleasant summer beverage; the stuff slightly blistered our finger.

The most prominent show of gas engines is made by the manufacturers of the "Stockport" gas engine. The exhibit is the more noticeable from one of the engines driving a Paterson and Cooper dynamo, which supplies six arc lamps. It is claimed for the "Stockport" engine that it is still as economical as any in the consumption of gas, with an advantage on its side of lower cost of manufacture.

The Atkinson "Cycle" gas engine and the Crossley "Otto" gas engine are also exhibited by the respective manufacturers, but there was apparently nothing in either that could be noticed as improvements of recent date.

Messrs. S. Griffin & Co. have a novelty in a portable hydro-carbon gas engine. On the one frame is placed the usual gas engine and a generator for making gas from petroleum. Economy results from this arrangement, partly from the greater effect produced in the cylinder from ignited gas over the petroleum spray, as in other petroleum engines, and again from the saving of trouble and labour in keeping the machine clean.

The "Campbell" Gas Engine Company also run gas engines of their type, but this is somewhat similar to the "Stockport" in essential points.

Messrs. Harvey Graham show their "Ritter" patent self-acting lubricator for stationary, marine, and locomotive engines. It is worked by a simple mechanical motion from any moving part of the engine; consequently the feed is automatic, and when the engine stops the supply of oil ceases. It is claimed that there is in this machine absolute reliability in working, great saving in oil, and no noise in action.

### REVIEW.

*Rules for the Concentric Wiring of Buildings and Ships.* By J. D. F. ANDREWS, M.I.E.E., A.M.I.C.E.

These rules are the outcome of the author's experience during many years practice as a specialist in the employment of concentric wiring, and he hopes that they will form a guide showing those interested in the introduction of the system the importance of carrying out the work in a uniform and substantial manner, applicable to a large systematic commercial business.

An advertisement on the cover sets forth the advantages of the concentric wiring over the two-wire system, and claims a greatly reduced fire risk, for the reason, as the author elsewhere states, that although electric lighting is undoubtedly safer than any other means of illumination, still many fires have taken place, the causes of which have been a source of study and discovery to many minds, with the result that they have been traced to four causes: first, when the two wires are brought accidentally into contact with each other; second, when a bridge of poor conducting power forms between the two wires; third, when the wires get broken by accident or corrosion, and the electricity jumps across the gap; fourth, when any derangement takes place in the switches, fuses, or fittings whereby a loose contact is made. Of all these sources of danger in electric light apparatus and wiring there is only one—namely, the first, for which a special apparatus has been invented to check its effect. The name given to this contrivance is the fuse or cut-out, and it consists simply of a wire of metal which is easily fusible, and as it is the nature of electricity to generate heat in its conductors, this wire, which forms part of the conductor

to the light, fuses, if the current passing increases to an excess, which is what takes place when the two conductors are accidentally brought into contact.

It has not been found possible with the existing practice of wood casing and two wires to make any provision against the other sources of danger, which really are the most serious. But by the system of concentric wiring these dangerous properties have been entirely set aside by a mode of construction, and the simplicity and substantial and durable character of electric lighting greatly enhanced. The wires used in this system are constructed one inside of the other, separated by an insulating substance. By this construction the conductors are arranged so near to each other that it is impossible for one of the wires to be deranged without affecting both, and causing that defect which is protected by the fuse. When any such accident does occur, it is contained within the surrounding tube conductor, and it only lasts for an instant.

It is also claimed that concentric wiring is cheaper in first cost than the two-wire system; this we venture to doubt, providing that every particular and detail is constructed in accordance with Mr. Andrews's rules. Our opinion is supported by Mr. Rankin Kennedy, who says that the single wire system is more expensive to erect than the two-wire system, if the work be properly done.

Considerable care has been given to render the rules complete, so as to embrace all points that may arise in practice. From a note at the end, we also infer that they are satisfactory to the fire insurance companies; the note states that installations carried out in accordance with the rules can be insured at the ordinary rates.

Some extra rules for ship lighting are appended, which should be valuable to those who are not much acquainted with electric work on board ship.

## NOTES.

**Telephony in the North.**—It is reported that a deputation from Rothesay has called on Mr. Muirhead, whose name has of late come so much before the public in connection with the £4 per annum telephone company, and he has been asked to estimate for the erection of wires; and the establishment of an exchange in Rothesay, to be fitted up with French instruments. The Postmaster-General is also being asked to grant a license to carry it on, on the usual terms.

**Accident at a Paris Lighting Station.**—Three firemen employed at the electric lighting "installation" at the Palais Royal, which supplies the Comédie Française and the neighbourhood around, were injured seriously at a late hour on Monday night by the explosion of a steam pipe connected with the engine. Many of the lights in the theatre were extinguished temporarily, but there was no interruption in the performance. On Tuesday evening one of the wounded men died.

**A Curious Break in a Converter Primary.**—A correspondent writing from Chicago to the *New York Electrical Engineer*, says:—I would call the attention of your readers to a sample of wire taken from the primary coil of a converter, which shows an apparently unaccountable break. The ends of the break are fused, while the insulation has not been charred except close to the break. There was nothing to show that this was caused by any cross with the secondary coil, or by any escape to ground. It is accepted by some people as being a freak of lightning, and has come to be such a common occurrence as to amount to a very serious trouble. I would like to enquire whether others have noticed this difficulty, and whether there is any good explanation to give except a fault in the copper finally resulting in a break.

**Telephone Communication.**—The introduction of the telephone to Campbelltown for business purposes is to take place this week, when a telephone is to be established between the Post Office and the shipbuilding yard. Several business firms in the town have already made enquiries with a view to the extension of the telephone system, and the establishment of an exchange at the Post Office.

**Official Report on the Kemmler Execution.**—Dr. Carlos F. Macdonald, president of the State Commission in Lunacy, has furnished Governor Hill an official account of the recent death of William Kemmler, at Auburn Penitentiary, by electricity. He says:—"Compared with hanging, in which death is frequently produced by strangulation, with every indication of conscious suffering for an appreciable time on the part of the victim, execution by electricity is infinitely preferable, both as regards the suddenness with which death is effected, and the expedition with which all the immediate preliminary details may be arranged. By the latter method the fatal stroke renders its victim unconscious in an infinitesimal fraction of a second, so small as to be beyond the power of the human mind to estimate, while, at the same time, it disintegrates the nerve tissues and blood to an extent which insures an absoluteness of death in a shorter space of time than is possible by any other known method. In other words, it is the surest, quickest, most efficient, and least painful method that has yet been devised." Dr. Macdonald makes the following recommendations:—1. The statute providing for the execution of criminals by electricity should be amended so as to provide for but one plant, to be located in the central part of the state, in a building especially constructed for the purpose, the apparatus to be in charge of and operated by a competent, accredited electrician. 2. The engine and dynamo should be especially constructed for the purpose, and should be capable of generating an electromotive force of at least 3,000 volts, in order to insure the maximum voltage that would be necessary, and at the same time cause no injustice to any electrical lighting company, such as is likely to be the case so long as commercial dynamos are used in executing criminals. 3. The voltmeter should be located in the execution room, and a competent and responsible official should be detailed to take the readings of the meter before and at the instant the current is applied. The voltage should not be less than 1,500, nor more than 2,000, and should be a matter of official record. The prisoner's resistance should also be taken immediately before bringing him into the execution room.

**Storage Cars.**—There is yet a good time coming for the storage battery tramcar. The *New York Electrical Engineer* of the 15th inst. contained figures which show that as many storage cars are running to-day as there were of the overhead conductor system only two short years ago. In such a city as New Orleans, for example, the storage system is the only substitute for horses, and there, says our contemporary, it will achieve one of its greatest triumphs. The advocates of the secondary battery on this side will doubtless rejoice to think that the day is not far distant when the same progress will be shown in the United Kingdom.

**Increased Business of the American Westinghouse Company.**—The business of the Westinghouse Electric and Manufacturing Company has received an extraordinary boom during the last month. The shops are now running at their full capacity day and night, and the company has still orders ahead to keep it busy the entire winter. This large increase in the work is especially caused by the wonderful success of the street car motor lately brought out. The manufacture of alternating current apparatus has also gained considerably, and the new Westinghouse system of alternating current arc lighting is rapidly becoming a popular method of illumination.

**Electric Light and Potential Differences.**—Sir David Salomons has contributed to the October number of *Lippincott's* a treatise on electric lighting. It is, of course, of a popular nature, but the following extract may be of service to the ever-increasing race of primary battery inventors who will insist that their galvanic couples are pre-eminently suited to the requirements of electric lighting:—"A lamp (incandescent) intended to give a certain light with a given pressure would give less than half its light with a fall of 10 per cent. in pressure. On the other hand, a 4 per cent. increase of pressure above the normal would produce at least double the light intended." Primary batteries, therefore, intended for electric lighting become almost useless when the difference of potential at their terminals is allowed to fall below 10 per cent.

#### The Electric Lighting of Paris and Foreign Material.

—*Le Matin* publishes the following remarks on the specification of charges of the electric lighting of Paris:—"One of the good results which the Municipal Council's specification of charges imposed on the concessionaires of sectors has certainly brought about has been to force foreign companies, which hitherto had imported their machinery and accessories to manufacture in France, which, as will be understood, is a very great advantage for French manufacturers and workmen. The most striking case is that American company, Babcock and Wilcox, the well-known makers of multi-tubular boilers. Though for four or five years this company has nearly wholly constructed its boilers in France, it only entirely carried them out in France when the Popp order was given to it. This company found itself, by the decision of the Municipal Council, before the alternative of refusing the order which had been given it—a large order of about 10,000 horse-power, intended for a large installation for the electric lighting of the city—or of entirely constructing it in France. The Babcock and Wilcox Company did not hesitate. It entered into an arrangement with Le Creusot, which undertook the construction of the Babcock and Wilcox boilers." From this summary of the facts, it will be seen that the Babcock and Wilcox Company found itself in an exceptionally difficult position, on account of the requirements of the Paris Municipal Council in regard to the secret construction of certain parts of its boilers. Nevertheless, the order was such an important one that a *tour de force* was necessary. The company rose to the situation, as may be judged from what precedes.

**Electric Trains with Storage Batteries.**—The practicability of working electric trains by means of storage batteries still remains an open question; but recently some continuous trials have been made on the Lehigh Avenue Street Railroad in Philadelphia, which appear to be of a satisfactory character, though the total time during which the trial has lasted is hardly sufficient to justify very sanguine hopes of the ultimate success of the system. On the track in question four cars have been operated continuously during the last four months with cells of the railroad type described in our leading pages. This road has numerous curves, and grades as heavy as  $5\frac{1}{2}$  per cent. These have taxed the cells to their utmost, the 100 cells on each car frequently being discharged at the rate of 45 electrical horse-power. During the month of August past, these cars alone carried 59,000 passengers, with frequent loads of 100 passengers on a car. The batteries have frequently made runs of 63 miles with a single charge under these conditions, thus giving a good indication of their increased efficiency where the conditions are more favourable as to grades and curves.

**Fire at Boston Caused by Electricity.**—It is said a fire, which broke out on Sunday last at the office of the Western Union Telegraph Company, was caused by an electric light wire crossing another wire. Work was temporarily suspended.

**The Electrical Transmission of Power.**—For the electrical power transmission installation near Grenoble the water is dammed so as to give an effective head of 230 feet, and is conducted by a steel pipe to the turbine. The generating dynamo is coupled directly to the horizontal shaft of the turbine, and is connected to the two cables by an aerial line, by which the power is transmitted to the motor at Montier, a distance of a little more than three miles. The following particulars are from *Le Genie Civil*:—Generator, 300 horse-power, 240 revolutions per minute; motor, 200 horse-power, 300 revolutions per minute; pressure, 2,850 volts; current, 70 ampères; resistance of line, 3,474 ohms; resistance of dynamo fields, 0.950 ohms; resistance of dynamo armature, 0.984 ohms; resistance of motor fields, 0.731 ohms; resistance of motor armatures, 0.690 ohms; total resistance of circuit, 6.829 ohms; electrical efficiency, 83 per cent.; mechanical efficiency, 65 per cent. This plant has been running since November last. Four men are employed—two at the generator and two at the motor—each being in attendance for twelve hours. A telephone line is run on the same poles as the working line. The line has been struck several times by lightning, but both generator and motor were fully protected. The power is used for driving a paper mill, and the cost is found to be much smaller than when steam was used.

**Arc Lamps with Alternating Currents.**—Mr. Steinmetz, of New York, is stated to have succeeded in effecting the feeding of 125 arc lights, Westinghouse pattern, by means of an equal number of small transformers connected in series on a circuit which carried a constant current of 30 ampères. Each lamp works at 50 volts and 10 ampères, so that for each lamp brought into circuit, the tension increases about 17 volts in the primary circuit, on which, however, it never exceeds 2,000 volts. The advantage of this system is the reduction of the potential in the lamp circuit, while a line at high tension is maintained. The lamps are the same as for continuous current, but with divided electromagnets. They are fitted with special flat and broad carbons, 20 cm.  $\times$  5 cm.  $\times$  0.8 cm. to 1.5 cm., having a durability of 40 hours. The Westinghouse-Stanley machine, which supplies the primary current, has a high self-induction owing to the induced coil being wound with a very large number of turns of wire, and consequently the current varies very slightly with external resistance, about 2 per cent. for tensions varying at the terminals from 1,000 to 3,000 volts. In order that the lamps should work under the best conditions, the speed of alternations of the current was reduced to one-half, the rate adopted being 130 complete periods per second.

**Indurated Fibre for Conduits.**—We read in the issue of the New York *Electrical Engineer* for September 17th that the use of indurated fibre pipes for underground telephone work has assumed considerable importance in Philadelphia. It is made by a patented process from long wood fibres, separated, washed free from all saps and gums, moulded while in a pulpy state into the requisite size and shape, and then subjected to great hydraulic pressure. After this it is treated and hardened by a special chemical process, so that it is rendered impervious to moisture or to the action of acids or gas. It is very tough and durable, and will withstand very great crushing strains. The tensile strength is about 1,100 lbs. to the square inch. Its weight is about one-fifth that of iron for equivalent service in pipe form. It will resist over 200° of heat, is insensible to the greatest cold, and is easily handled. For electric lighting purposes, the man-hole chambers are lined with the indurated fibre, the wires are led through to the pipes by means of rubber tubes, and the chamber is packed with phenicite, a plastic compound resisting moisture and high electrical temperatures. The joints and collars in the service pipes are also cemented with phenicite. The pipes are laid in a concrete of cement, sand, and gravel.

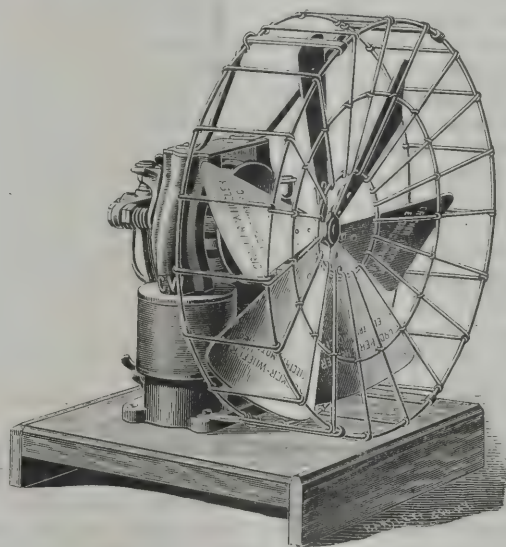
**The Electric Tramcar Accident at Florence.**—The following account of this unfortunate occurrence is taken from a letter to the *Standard*, and as it gives a pretty full description of the accident, may be worth reproduction for future reference:—The line (about 5 miles in length) is laid partly on one side, partly in the centre of the high road, winding, by a long loop, up the steep slope of the well-known Fiesole Hill, and is worked on Sprague's (American) system, by means of a somewhat complicated arrangement of overhead wires, which, owing to the numerous curves, and to the line changing from one side to the other, or being in the centre, are held in position by a series of additional wires, fixed to poles on one or both sides of the roadway. The two sharpest, almost semi-circular, curves occur at a distance of about half a mile from the summit level—viz., the Fiesole Terminus, one of these curves being less than two chains in radius, and the other being so sharp that, in order to avoid it, a back-shunt had to be adopted. The accident occurred on the first of these curves. A car containing 36 passengers (six more than the regulation number) left the summit, and the guard having by mistake failed to apply the current to the brake, the vehicle rushed unchecked, and with tremendous velocity, down an incline of 1 in 14 (7 in a 100), left the rails at the tangent of the curve, and rushed with terrific force against a parapet wall, five passengers being killed on the spot, and 20 more or less seriously injured. The immediate and avowed cause of the accident is said to be the negligence and inexperience of the brakesman, who was himself injured and placed under arrest; but, apart from the dangerously sharp curve referred to, it is difficult to see how an efficient and responsible staff, fit to deal with so powerful and sensitive a motor as electricity, can ever be found to work this line, when a brakesman, who on each journey has the lives of 30 passengers in his hands, receives the miserable wages of a little over two francs per day, and has to be on duty from 6 a.m. to 10 p.m. It is needless to say that the service on the line was at once and entirely stopped by the local authorities pending the inquiry into the accident, which will, moreover, entail on the company heavy compensation. It is a question whether, on a line of this nature, with steep grades and sharp curves, the rack system, or a combination of electric motive power and the rack, would not answer much better than electric power pure and simple, unless additional and independent brakes are provided to ensure safety."

**Telegraph Cable Construction.**—The *Times* has received the following communication from the Foreign Office:—A despatch has been received from her Majesty's Ambassador at Madrid, enclosing copies of a Royal decree authorising fresh tenders to be invited for the construction of the telegraph cables between the Peninsula and the Spanish possessions on the North Coast of Africa. The new conditions are slightly different from those referred to in the notice sent to the newspapers on the 23rd of August last from the Foreign Office. None of the tenders received in answer to the first application have been accepted. The conditions (in Spanish) may be seen at the commercial department of the Foreign Office, London, between the hours of 11 and 5.

**Electric Light in the City.**—The *City Press*, in a recent issue, raises the following query:—"Is it not time that some information should be given as to what steps are being taken with a view of carrying out the contracts for electric lighting of the City entrusted some months ago to the Brush Company and to the Thomson-Houston Co.? The contracts have, I believe, been signed, and there was a limit of time within which the works were to be completed, but so far as I know not the smallest commencement has been made. Indeed, rumour has it that in both instances subsidiary companies are about to be formed to undertake the business. At any rate we are entitled to know something of the matter."

**Englishmen at Mr. Edison's.**—A few days ago over 400 persons, comprising delegates to the meeting of the Mining Engineers and British Iron and Steel Institute, visited the Edison laboratory at Orange, N.J., where they obtained a peep at the famous workshops. Sir John Kitson and many well-known on this side of the water had an opportunity of chatting with Edison, who, an American paper says, derived great pleasure from the visit.

**The Crocker Wheeler Motor.**—These motors (of which we give an illustration) are essentially constructed for use with small currents on central station circuits. They are made from  $\frac{1}{8}$ th to 3 H.P., and can be put in circuit with either incandescent or arc lights. The want of such a motor made in a perfect style has been long felt in England, the motors that have already been supplied not giving satisfaction, mainly owing to want of care in the selection of material and the construction of details, and the success which the Crocker Wheeler motors have



achieved in the United States, there being over 2,000 installed in one year, is due to the perfect construction of the apparatus, its durability, and greater efficiency compared with its size. They are mainly used at present for pumps, fans, lifts, small machinery, &c., but when once introduced into England we have no doubt a great many uses will be found for them, and we think it especially in the interest of central stations to recommend the use of motors in order to make them known, and no doubt in time a considerable revenue will accrue from them. The sole agency for this country has been obtained by the General Electric Company, Limited.

**Electric Lighting at Harecastle.**—Messrs. Woodhouse and Rawson, of Kids Grove, have just completed a very successful installation of the electric light at the Harecastle Hotel. The plant consists of a 110-volt dynamo, driven by a 10 H.P. engine, which supplies 90 16-C.P. lamps.

**The Popularity of Electro-technics.**—With reference to our Note under the above heading, we are informed that of the 596 students receiving technical instruction several hundreds are men already in the electrical industry who are engaged in electrical factories during the day, and who are therefore already provided for.

**Electro-deposition.**—Prof. Andrew Jamieson states that our calculations last week on the electro-deposition of copper exactly bear out his own figures at page 345 of the 6th edition of Munro and Jamieson's pocket-book, viz.:—1 lb. of pure copper deposited requires 4 H.P. We might have added that this will be at least 6 to 8 H.P. indicated, taking everything into account. We hope that Mr. Jamieson may be able to endorse our further contribution to this subject.

**The O. S. A.**—On Friday evening last, the Old Students, Association of the City and Guilds of London Institute held their sixth annual dinner at the Holborn Restaurant, with Dr. Sumpner in the chair. Amongst the guests, we noticed the familiar faces of Profs. Perry and Silvanus P. Thompson, Mr. Kapp, Mr. A. P. Trotter, Mr. Biggs, Mr. Saunders, Q.C., Sir Owen Roberts, and others. Several good speeches, appropriate to the occasion, were made during the course of the evening, and these were alternated with songs and instrumental selections. The number of old students present did not adequately represent the strength of the Association; but we trust that through the energetic endeavours of Mr. W. B. Esson, the President-elect, Messrs. Reckenzaun, Albion Snell, and Reginald Jones (secretary), a new impulse will be given to the gatherings, whether for serious business or social enjoyment. Six years is not a very extended period upon which to form a judgment upon the future of the "Old Students," but we believe that, in view of the number of young men now studying for the electrical profession, such a body might develop into one of a highly useful nature in after years, and we hope that now the helm of the Association is in the hands of practical men who can understand and appreciate the wants of their members, the new session will be the turning point in the somewhat chequered career of these budding scientists and engineers. Success or failure in newly-formed societies may generally be attributed to those in office as much as to any special inducements which may be offered to intending members. Good leaders will always command a large following, and we shall now expect that *esprit de corps* amongst the Old Students which has hitherto been somewhat lacking. To the President-elect and his fellow-workers we wish all success, for we feel well assured that nothing will be wanting on their part to deserve it.

**Telegraphic Communication with France.**—A telegram from Paris, dated yesterday, says:—"At a Cabinet Council held this morning it was decided to sanction the laying of a new telegraphic cable between France and Denmark, in order to obviate the frequent interruptions of communication at present occurring between the two countries. The Ministers also decided to establish telegraphic connection between Marseilles and Tunis, and Marseilles and Oran."

**The Whittingham Magazine Fuse.**—To replace an ordinary cut-out fuse when burnt out it is necessary to perform several small operations which entail a certain amount of trouble, and there is, besides, a risk that the clamping of the wire to the frame may not be efficiently done. In the Whittingham cut-out (an American device) the burnt out fuse is replaced by simply turning a knob through a half revolution. The fuse wire is contained in a small non-conducting cylinder carrying on its spindle a spool on which is wound the fuse wire. On turning the cylinder a wedge-shaped flange or its periphery serves to open a spring jaw, and as the thick end of the flange leaves the clip the jaws come together and catch the end of the fuse protruding from the rear of the wedge. Another half turn of the knob causes the sharp end of the flange to enter between the jaws of the other clip and spread them apart as it passes. The end of the fuse being now held by the first clip, is drawn out from the spool as the cylinder is turned. When the revolution of the cylinder is completed both clips are in action and the fuse wire is firmly held. The convenience of this arrangement is undoubted, but the idea of a magazine fuse is not new, as we have the recollection of seeing such a device some six years back, the manipulation in replacing a burnt out wire was accomplished by the simple plan of opening and shutting the lid of the fuse box.

**Whitby Applies for an Order.**—The District Local Board of Whitby (Yorks) will apply to the Board of Trade for a provisional order.

**Interesting to Engineers.**—The Journal of the Franklin Institute for this month contains the first portion of a paper by Chief Engineer Isherwood, U.S.N., on "The Processes of Steam in its Development of Power by means of the Steam Engine." It is a reprint of the lecture delivered by this gentleman before the Sibley College of the Cornell University, Ithaca, N.Y., in December last. We also note a paper in the "Transactions of the American Society of Civil Engineers" for July last, and which has just come to hand, by Prof. Robert H. Thurston, entitled "A Practical Method for Reducing the Internal Wastes of the Steam Engine."

**The Ferranti Mains.**—It is stated that so much of the new cable is down and at work, that the induction effects, which so greatly troubled the Post Office authorities, have been quite eliminated, and everything is now running well; we believe this statement is not yet borne out by facts, and is decidedly premature.

**Strike of Telegraph Operators.**—Some inconvenience was caused lately on the Mackay system in the United States by a strike amongst their operators, but it appears to have soon been terminated by the demands of the operators being granted in full. The demands were for increased wages, and a promise that only competent men would be employed. This latter request arose from the custom of telegraph pupils being employed to work for nothing until they become expert in the use of the instruments, when they generally offer to work at a certain station for \$10 a month less than the ordinary operator is being paid for it.

**Accumulator Explosions.**—The *Daily Telegraph* of Tuesday had the following paragraph in "London Day by Day":—"An extraordinary explosion took place the other day on board Earl Poulett's steam yacht, the *Pathfinder*, while lying in Portsmouth Harbour, but, fortunately, without injuring anyone. The vessel is lighted throughout with the electric light. Formerly the accumulators were stowed in the coal bunkers, but, as the spot was not easy of access, they were this season placed on deck, encased in lead and covered with teak. The dynamo was worked by a small boiler in the engine room, which also heated the water for general supply throughout the vessel. During a violent storm of rain the steward reported a leak in his cabin from the deck, and, on going to examine the cause, Lord Poulett discovered that the water came down the hole through which one covered wire passed from the accumulators and went to the dynamo. As it was rather dark, he struck a wax match, and immediately a terrific explosion took place, the yacht being shaken from stem to stern. On going on deck, Lord Poulett saw that the whole of the accumulators had exploded, blowing the teak cases to pieces, and sending the glass fragments and the splinters into the air. The dynamo was running at the time, and only ten minutes previously his lordship and the engineer had been examining the cells, with the lids of the cases open, to see in what state the acid was. Each cell had a vent-hole on the top for escape of air and for ventilation, so that how the explosion originated remains a mystery. The electricians declare it to be one of the most extraordinary things they have ever known, and can in no way account for it, as it has hitherto been thought that under no circumstances could gas be generated in accumulators. It would be satisfactory, therefore, if scientific men could find some solution to the problem, otherwise launches and yachts, where electricity is employed, will be looked upon as too dangerous for holiday cruising."

**Subway Rentals.**—The electric light companies complain that the rental for ducts in the new subways in New York are prohibitive, that some companies are being illegally favoured, and that there is no way of deciding the matter except by appeal to the law courts.

**The Institution of Civil Engineers.**—Amongst the subjects suggested for papers for the forthcoming session of this Institution are the following:—"The Lighting of Railway Carriages by Oil, Gas, and Electricity Compared;" "Electrical Traction for Roads and Railways;" "The Design and Arrangement of Electric Supply Stations and of Electric Distributing Apparatus for Domestic, Trade and General Service in Towns, particularly as to Economy and Safety;" "The Comparative Advantages of Gas and Electricity for Lighting Purposes;" "The Application of Electricity to Bleaching;" "Electric Mining Machinery for Pumping, Hauling, and Coal-Cutting in Mines and Collieries;" "The Application of Electricity to Smelting and Metallurgical Operations;" "The Electro-Deposition of Copper;" "The Cost of the Production and Distribution of Electrical Energy;" "The Distribution and Application of Electric Power in Towns;" "Electrical Measuring Instruments, such as Ammeters, Voltmeters, Power-Meters, and Supply Meters."

**National Telephone Company, Limited, Glasgow District Electrical Society.**—This society was inaugurated on Thursday evening, the 16th inst., D. Kinross, cashier of the company, presiding. The office bearers and committee of management were appointed for the ensuing session. The first paper of the session was read by Mr. Aitken, district engineer of the company, his subject being "The Exchange." He recommended single core for all non-multiple boards for compactness and speedy operating. His paper was very interesting and instructive, and was well received by a large gathering of the *employés*.

#### NEW COMPANIES REGISTERED.

**Petronite Syndicate, Limited.**—Capital £6,060, in £1 shares. Object: To adopt an unregistered agreement of 1st October, entered into with Wm. Sinclair, of Hull. To acquire and work patents, inventions and secrets relating to the preparation of enamel, varnish, damp coursings, insulators, coating for submarine cables, &c. Signatories (with 1 share each), F. Gordon Pape, Wm. Gillyott, C. Muirhead, \*G. Bohn, \*D. W. Sissons, J. B. Willows, and T. H. Sissons, all of Hull. The signatories denoted by an asterisk, and R. Barton and Thos. Bailey, are the first directors. Qualification, £100 in shares stock. Remuneration, £10 10s. each per annum, and, in addition, 10 per cent. on all moneys received on the sale of all or any of the patents or secrets of the company. Registered office, Cogan House, Bowl Alley Lane, Hull. Registered 16th inst. by J. A. Jackson and Son, Hull.

**Electro-Chemical Syndicate.**—Capital £5,000, in £1 shares. Objects: To acquire and develop patents, and to carry on any business, whether manufacturing or other, in connection with the working of the same; to acquire or to construct engines, machinery, and appliances of all kinds. Signatories (with 1 share each): C. C. Marriott, 57, Lavender Sweep, S.W.; T. Trummell, Monument Buildings; G. W. Crosby, 20, Abchurch Lane; G. Fumey, Dashwood House; A. Bissland, 4, Copthall Buildings; J. H. Waldock, 16, Chadwick Road, Peckham; E. J. Wills, 46, Mortimer Street, W. Registered 16th inst., without special articles of association, by Lovell and Trummell, Monument Buildings, E.C.

**British Insulated Wire Company, Limited.**—Capital £60,000 in £5 shares. Objects: To manufacture and deal in wire, wire ropes and cables of all kinds, and to carry on business as electricians and as manufacturers of and dealers in electrical apparatus. Signatories (with 1 share each): J. B. Atherton, J. Atherton, Huyton, Lancashire; T. P. Hewitt, S. H. Hartley, Prescott; W. E. Brigg, Keighley, York; J. H. Dodd, Liverpool; J. Beckett, Huyton. The signatories are to appoint the first directors, remuneration £200 per annum, and in addition 10 per cent. of the nett profits remaining after

payment of 10 per cent. per annum dividend on the ordinary shares. Registered 20th inst. by T. T. Hall, 22, Chancery Lane; solicitors, J. and H. Gregory, Leslie and Hartley, Liverpool.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Schanschieff Electric Light and Power Company, Limited.**—At a general meeting of this company, convened by the liquidators, and held at 32, Poultry on the 17th inst., the accounts of the liquidators, showing the manner in which the winding-up of the company has been conducted and its property disposed of, were laid before the meeting, and were approved and adopted. It was further resolved that the accounts, books, and documents of the company may be destroyed after the lapse of three months.

**National Telephone Company, Limited.**—The annual return of this company, made up to the 12th July, was filed on the 17th inst. The nominal capital is £4,000,000, divided into 740,000 ordinary shares of £5 each, 15,000 first preference shares of £10 each, and 15,000 second preference shares of £10 each. The shares taken up are as follows: 438,984 ordinary, upon which the full amount has been called; 15,000 first preference, upon which the full amount has been called; and 15,000 second preference, upon which £8 per share has been called. The calls paid upon ordinary shares amount to £2,194,920, upon first preference £150,000, and upon the second preference to £120,000.

**Andrews and Preece, Limited.**—The statutory return of this company, made up to the 14th August, was filed 10th ult. The nominal capital is £25,000 in £10 shares, 300 of which are deferred shares; 599 shares are taken up, 300 and 226 ordinary being considered fully paid. Upon 73 ordinary shares £5 per share has been called up, the calls paid amounting to £345, and unpaid to £20.

**Thornebury Miners' Safety Lamp Company, Limited.**—The statutory return of this company, made up to the 17th ult., was filed on the day following. The nominal capital is £50,000, in £1 shares. 30,050 shares are taken up, 20,540 of which are considered as fully paid. Upon 7,480 shares 15s. per share has been called, and upon 2,030 the full amount. The calls paid amount to £6,968, and unpaid to £672.

#### CITY NOTES, REPORTS, MEETINGS, &c.

##### Eastern Extension, Australasia and China Telegraph Company, Limited.

The following report and accounts for the half-year ended 30th June, 1890, was submitted to the thirty-fourth ordinary general meeting, 22nd October, 1890, held on Wednesday last, at Winchester House, Sir John Pender in the chair.

"The usual statements of account for the half-year ended 30th June, 1890, are herewith submitted.

"The gross receipts, including Government subsidies, have amounted during that period to £254,856 18s. 10d. against £256,757 3s. 2d. for the corresponding half-year of 1889.

"The working and other expenses, including £24,508 3s. 10d. for cost of repairs to cables and expenses of ships, absorb £76,670 9s. 3d. against £73,773 10s. 2d. for the corresponding period of 1889, leaving a balance of £178,186 9s. 7d. From this is deducted £2,960 19s. 7d. for income tax, and £38,549 14s. 7d. for interest on debentures and contributions to sinking funds, leaving £136,675 15s. 5d. as the net profit for the half-year. Against this £1,642 11s. 11d. has been charged for additions to staff quarters, and £712 16s. 1d. for expenses in connection with the recent Paris International Telegraph Conference, leaving an available balance of £134,320 7s. 5d.

"One quarterly interim dividend of 1½ per cent., amounting to £31,250, has been paid during the half-year, and another of like amount will be distributed on the 15th instant, leaving £71,820 7s. 5d. to be carried forward.

"The duplication of the New Zealand cable, and the partial renewal of the Madras-Penang section referred to in the last report have been successfully carried out during the half-year under

review, and the cost, amounting to £188,433 15s. 6d. and £80,848 1s. 3d. respectively, has been charged to the general reserve fund, which, after being credited with the profit of £21,103 3s. 4d. made on the sale of investments, and the interest received during the half-year, now stands at £472,713 15s. 3d.

"The subsidy granted by the Spanish Government in respect of the Manila cable expired on the 1st May last, when the balance of the 5 per cent. debentures issued to provide the capital for this cable was paid off, and as the interest and sinking fund contributions have now ceased, there will in future be a saving of revenue on this account of about £5,000 per annum.

"The company's £320,000 six per cent. debentures mature for payment at par on the 1st February, 1891, and your directors have decided to pay them off on that date by issuing a similar amount of 4 per cent. mortgage debenture stock. An extraordinary general meeting will be held immediately after the ordinary meeting at which the necessary resolution will be submitted for the shareholders' approval.

"Negotiations have been entered into with the Governments of Australasia for the establishment of reduced rates to Australia and New Zealand, and the matter is now under consideration in the colonies.

"Arrangements have also been made with the Indian Government for improving the International service; in connection with which the company has decided to duplicate the Madras-Penang cable, and a contract has accordingly been entered into with the Telegraph Construction and Maintenance Company for carrying out the work, which is expected to be completed early next year.

"During the half-year the Tonquin-Hongkong section has been partially renewed by the insertion of 67 nautical miles of new cable, and the operation will be continued as opportunities occur until the line is put into good order.

"The company's maintenance ships have been employed on various cable repairs, but no interruptions materially affecting the revenue have occurred during the past six months. Unfortunately, however, since the close of the half-year telegraphic communication with Australia has been totally interrupted, from the 11th to the 20th July, in consequence of the sudden and simultaneous breaking, through volcanic action, of the three Java-Australian cables near Banjoewangie (Java). This was the more disappointing as it was only last year that the cable to Western Australia was laid mainly with a view to averting such a contingency, but as only two interruptions from volcanic causes have been experienced during a period of nearly 20 years, it is hoped that the cables will now have a long immunity from further trouble of this nature."

The CHAIRMAN, after going over the figures in the report, said the increase in working expenses was accounted for by the fact that the repairs had been heavier than the corresponding period of last year. The laying of the duplicate cable between Australia and New Zealand had since the last meeting been successfully completed, also a partial renewal of the Madras-Penang section; the cost of the two operations had been debited to revenue account. He had often had occasion to explain to them that the object of the company was to keep down capital and keep the system in thorough repair; in that way satisfactory dividends were obtained, and a goodly sum placed to the reserve. On account of the Manila subsidy arrangement having expired and the paying off the capital required for this cable, the company would save about £5,000 a year. The 6 per cent. debentures would be shortly changed to 4 per cent. debentures; a resolution to this effect would be brought before them at the close of the present meeting. Passing on to the question of cable renewals, it was a necessity to have duplication, so that the revenue would never be disturbed. Unfortunately they had nine days' interruption on their cables to the Australian colonies, although they had three cables at work; this was caused by an earthquake. Although rare, a similar occurrence to this happened about 20 years ago; this showed the importance of duplicating even with three cables. It was in one sense unfortunate, though in another it was satisfactory to see how soon repairs could be effected. All these things led him to think that there was no company in the world which could compete with them. That was their strength; they were not monopolists, for they had no exclusive concessions, but they had gradually built up their position, and now they were impregnable. Coming now to the subject of the reduced tariff to Australia, the speaker said there had been a great deal of discussion. The present tariff, 9s. 4d., was reduced by them from 10s. 8d. five years ago. They were fully recouped for the temporary loss in about three years. Another agitation had now begun for a further reduction. Conferences were held with the Agents-General in London, men who were eminently qualified to look after the interests of the Colonies, and with them they resolved, in face of the increasing vitality in the merchant life of Australia and a guarantee from the Government, to reduce their charge to 4s. So confident did the board feel of the success of the scheme, that they were taking half the risk. The increased income to the company would more than justify that action, and at the next meeting they would be able to speak of the success of the scheme. Speaking of the Paris Conference, he would remind honourable shareholders that they anticipated things would go rather hard with them; such had not been the case, however, and they came out of the Conference unscathed. In conclusion, the speaker dwelt with satisfaction on the arrangement made with the Indian Government as to cable work in that part of the world.

The report was then formally moved and seconded.

A few questions were satisfactorily disposed of, and the report and accounts were adopted.

At the conclusion of the ordinary business, an extraordinary general meeting was held for the purpose of considering the following resolutions:—

(a.) "That the board of directors be, and are hereby authorised from time to time to create and issue mortgage debenture stock of the company to an amount not exceeding one-third of the share capital of the company for the time being issued and paid up, upon the terms that the aggregate amount of the said stock for the time being in issue, and the interest thereon, shall rank *pari passu* as a first charge on the undertaking and revenue of the company, the stock to be issued at such times, in such amounts, and on such terms and conditions as the board shall from time to time determine, for the purpose of redeeming by exchange or otherwise the outstanding debentures of the company, or any other purpose to which capital of the company may be lawfully applicable."

(b.) "That the board be, and are hereby authorised to make such provision as they think fit for the registration and transfer of mortgage debenture stock, and for the delivery of certificates thereof, and for the payment of the interest thereon, and generally as to the form and incidents of all documents relating to the said stock, but so that no such provision be inconsistent with paragraph (a) of this resolution."

These were carried unanimously, and the meeting dispersed.

### Brazilian Submarine Telegraph Company, Limited.

THE thirty-fourth ordinary general meeting was held at Winchester House, on Wednesday, under the presidency of Viscount Monck, who in his address remarked that the working of the company was satisfactory. They had paid a dividend of 7½ per cent., added £40,000 to the reserve fund, and paid off debenture debts to the amount of £15,300, which was shown in the report published in the REVIEW last week. There were favourable indications, so far, for the next half-year. Notwithstanding a satisfactory evidence of the state of things, they had undoubtedly a rock ahead of them, which was the termination of their concession, and which would run out in two years or a little over. Many things were being done, and he could assure them that the board watched the interests of the company with increasing vigilance as the time arrived for proper action. At the last meeting, observations were made with reference to statements in the original prospectus of the company. This was a subject on which he was very sensitive, as he was then, as now, chairman, and practically responsible for that prospectus. Of the feeling and disposition of the gentleman who made the remark towards the board he had not a word to say, as the utmost good feeling prevailed. He said truly that there were statements made with reference to a probable yield of 14 per cent. Now what they did on that occasion was an endeavour to establish a relation between the general mercantile movement in the kingdom and telegraphic communication. They did this on the experience of others; figures were quoted which were open to all. They said that the trade to and from the Brazils might be expected to yield 15 per cent.; it had nearly reached that point, and if they considered everything that had been done, he (the speaker) thought the management was open to little objection. During the period of their existence, 16 or 17 years, they had never paid dividends less than 5 per cent., while on some occasions they had reached 7½ per cent. The whole of the system had been duplicated out of revenue, and if the whole of the debentures raised for that purpose were now paid off there would still be a sum of £2,000 for reserve. The plant was in excellent order; the lines were working well; the receipts for the half-year showed an increase on the previous half-year. A decrease in the London expenditure was accounted for by the absence of law charges. An item in the account which was very large was the laying of land lines, which was not likely to occur again. In conclusion, the chairman referred to the death of Dr. Taylor, their Brazilian representative, whose place had now been filled.

Retiring directors and auditors being re-elected, the proceedings terminated.

**The Consolidated Telephone Construction and Maintenance Company, Limited.**—This company has declared an interim dividend for the half-year at the rate of £6 per cent. per annum on the preference shares and £5 per cent. per annum on the ordinary shares, both less income tax, payable on November 14th.

**West India and Panama Telegraph Company.**—The board recommend a payment of 6s. per share to June 30th last on the first preference shares, and £3 per share on account of arrears on the second preference shares. The sum of £1,500 is to be placed to reserve, leaving a balance of £322.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 17th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,842. The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending October 17th were £4,891.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (October 16).	Closing Quotation. (October 23.)	Business done during week ending October 23, 1890.	
					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	99 — 102		
1,549,160	Anglo-American Telegraph, Limited	Stock	49½ — 50½xd	49 — 50 xd	50½	49½
2,725,420	Do. do. 6 p. c. Preferred ...	Stock	85 — 86 xd	85 — 86 xd	85½	85
2,725,420	Do. do. Deferred ...	Stock	13½ — 14½	13 — 13½	13½	...
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12½	11½ — 12½	12½	11½
84,500	Do. do. 5 p. c. Bonds...	100	100 — 102	100 — 102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416...	3	1½ — 1½	1½ — 1½	1½	...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2		
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104		
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	5½ — 5½	5½ — 5½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,000	Cuba Telegraph, Limited	10	11½ — 12	11½ — 12		
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4½xd	3½ — 4½xd	4	3½
6,090	Do. do. 10 p. c. Preference	5	9 — 10	8½ — 9½xd	9	...
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½xd	13½ — 14½xd	14½	13½
70,000	Do. do. 6 p. c. Preference	10	14½ — 15½	14½ — 15½xd	14½	...
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109		
1,230,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	104 — 107	104 — 107		
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½xd	14½ — 14½xd	14½	14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102		
91,800	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg.	100	102 — 105	102 — 105	101½	...
325,200	Do. do. 5 p. c. Debentures, 1890, redeem. ann. drgs. to bearer	100	102 — 105	102 — 105	102½	...
145,300	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 reg.	100	101 — 104	101 — 104		
198,200	Do. do. do. to bearer	100	...	101 — 104		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8	7½ — 8	7½	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5½	5 — 5½	5½	4½
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid)	2	2 — 2½	1½ — 2½		
20,000	Fowler-Waring Cables, Nos. 301 to 20,000	5	3½ — 4	2½ — 3		
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	9 — 8½	9	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15	14½ — 14½	14½	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	16½	13½
15,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104		
230,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		
41,609	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18½ — 19½	19	18½
200,000	Do. do. 4½ p. c. Deb., 1896...	100	100 — 102 xd	100 — 102		
17,000	Indo-European Telegraph, Limited...	25	36 — 38	36 — 38		
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6½ — 7½		
100,000	Do. do. do. 6 p. c. Debentures	100	105 — 108	105 — 108		
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5½ — 6	5 — 5½	5½	5½
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4½ — 4½	4½ — 4½	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 12½	12 — 12½		
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½ — 10½	9½ — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8½ — 8½	8½ — 8½		
9,000	Reuter's, Limited	8	8½ — 8½xd	8½ — 8½xd	8½	...
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	½ — ...	½ — ...		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3		
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117		
78,949	Swan United Electric Light, Limited	5	5½ — 5½	5½ — 5½	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	45	44
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
58,000	United River Plate Telephone, Limited	5	3½ — 4	3 — 4		
146,128	Do. do. do. 5 p. c. Debenture Stock...	Stock	90 — 94	90 — 94		
3,200	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½ — 9½	8½ — 9½		
290,900	Do. do. do. 5 p. c. Debentures	100	98 — 101	98 — 101		
30,000	West Coast of America Telegraph, Limited	10	4½ — 5	4½ — 5		
150,000	Do. do. do. 8 p. c. Debs. repay. 1902	100	102 — 107	102 — 107	103½	103
64,174	Western and Brazilian Telegraph, Limited	15	11½ — 11½	11 — 11½	11½	11½
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7½	6½ — 7	6½	6½
27,873	Do. do. do. 5 p. c. Deferred	7½	4½ — 5½	4½ — 5		
200,000	Do. do. do. 6 p. c. Debentures "A" 1910...	100	103 — 106	103 — 106		
250,000	Do. do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106		
88,321	West India and Panama Telegraph, Limited	10	2½ — 3½	3 — 3½	3½	3
34,568	Do. do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 12	11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	14 — 15	14 — 15		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	122 — 127	122 — 127		
175,100	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 3	2½ — 3		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 1½—1½.—House-to-House Company (£5 paid), 5—5½.—International Okonite, Ordinary of £10 (£7 paid), 6½—7½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/-—13/-.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 471.)

Let me show you yet another experiment. This is the same electro-magnet (fig. 24) which has one flat pole and one rounded pole. Here is an armature, also bent, having one flat and one rounded pole. If I put flat to flat, and round to round, and pull at the middle, the flat to flat detaches first; but if we take round to flat, and flat to round, we shall probably find they are about equally good—it is hard to say which holds the stronger.

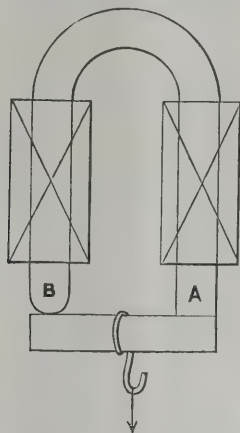


FIG. 25.—EXPERIMENT OF DETACHING ARMATURE.

The law of traction can again be applied to test the so-called distribution of free magnetism on the surface. This is a subject on which I shall have to say a good deal. We must therefore carefully consider what is meant by the phrase. Let fig. 26 be a rough drawing of an ordinary bar magnet. Every one knows that if we dip such a magnet into iron filings the small bits of iron stick on more especially at the ends, but not exclusively, and if you hold it under a piece of paper or cardboard, and sprinkle iron filings on the paper, you obtain curves like those shown on the diagram. They attest the distribution of the magnetic forces in the external space. The magnetism running internally through the body of the iron begins to leak out sideways, and finally all the rest leaks out in a great tuft at the end. These magnetic lines pass round to the other end, and there go in again, and the place where the steel is internally most highly magnetised is this place

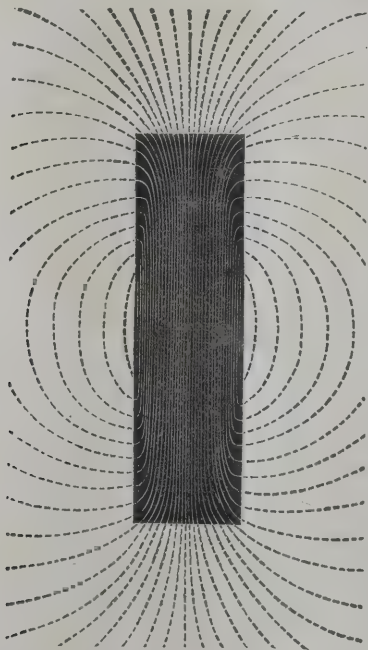


FIG. 26.—LINES OF FORCE RUNNING THROUGH BAR MAGNET.

across the middle, where externally no iron filings at all stick to it. Now we have to think of magnetism from the inside and not the outside. This magnetism extends in lines, coming up to the surface somewhere near the ends of the bar, and the filings stick on wherever the magnetism comes up to the surface. They do not stick on at the middle part of the bar, where the metal is really most completely permeated through and

through by the magnetism; there are a larger number of lines per square centimetre of cross section in the middle region where none come up to the surface, and no filings stick on. Now, we may explore the leakage of magnetic lines at various points of the surface of the magnet by the method of traction. We can thereby arrive at a kind of measure of the amount of magnetism that is leaking, or, if you like to call it so, of the intensity of the "free magnetism" at the surface. I do not like to have to use these ancient terms, because they suggest the ancient notion that magnetism was a fluid or, rather, two fluids, one of which was plastered on at one end of the magnet, and the other at the other, just as you might put red paint or blue paint over the ends. I only use that term because it is already more or less familiar. Here is one of the ways of experimentally exploring the so-called distribution of free magnetism. The method was, I believe, originally due to Plücker; at any rate, it was much used by him. This little piece of apparatus was arranged by my friend and predecessor, Prof. Ayrton, for the purpose of teaching his students at the Finsbury College.\* Here is a bar magnet of steel, marked in centimetres from end to end; over the top of it there is a little steel-yard, consisting of a weight sliding along an arm. At the end of that steel-yard there is suspended a small bullet of iron. If we bring that bullet into contact with the bar magnet anywhere near the end, and equilibrate the pull by sliding the counterpoise along the steel-yard arm, we shall obtain the definite pull required to detach that piece of iron. The pull will be proportional, by Maxwell's rule, to the square of the number of magnetic lines coming up from the bar into it. Shift the magnet on a whole centimetre, and attach the bullet a little further on; now equilibrate it, and we shall find it will require a rather smaller force to detach it. Try it again, at points along from the end to the middle. The greatest force required to detach it will be found at the extreme corner, and a little less a little way on, and so on until we find at the middle the bullet does not stick on at all, simply because there are here no magnetic lines leaking. The method is not perfect, because it obviously depends on the magnetic properties of the little bullet, and whether much or little saturated with magnetism. Moreover, the presence of the bullet perturbs the very thing that is to be measured. Leakage into air is one thing; leakage into air perturbed by the presence of the little bullet of iron, which invites leakage into itself, is another thing. It is an imperfect experiment at the best, but a very instructive one. This method has been used again and again in various cases for exploring the apparent magnetism on the surface. I shall use it hereafter, reserving the right to interpret the result by the light of the law of traction.

I now pass to the consideration of the attraction of a magnet on a piece of iron at a distance. And here I come to a very delicate and complicated question. What is the law of force of a magnet—or electro-magnet—acting at a point some distance away from it? I have a very great controversy to wage against the common way of regarding this. The usual thing that is proper to say is that it all depends on the law of inverse squares. Now, the law of inverse squares is one of those detestable things needing to be abolished, which, although it may be true in abstract mathematics, is absolutely inapplicable with respect to electro-magnets. The only use, in fact, of the law of inverse squares, with respect to electro-magnetism, is to enable you to write an answer when you want to pass an academical examination, set by some fossil examiner, who learned it years ago at the University, and never tried an experiment in his life to see if it was applicable to an electro-magnet. In academical examinations they always expect you to give the law of inverse squares. What is the law of inverse squares? We had better understand what it is before we condemn it. It is a statement to the following effect—that the action of the magnet (or of the pole some people say), at a point at a distance away from it, varies inversely as the square of the distance from the pole. There is a certain action at one inch away. Double the distance; the square of that will be four, and, inversely, the action will be  $\frac{1}{4}$ ; at double the distance the action is  $\frac{1}{4}$ ; at three times the distance the action is  $\frac{1}{9}$ , and so on. You just try it with any electro-magnet; nay, take any magnet you like, and unless you hit upon the particular case, I believe you will find it to be universally untrue. Experiment does not prove it. Coulomb, who was supposed to establish the law of inverse squares by means of the torsion balance, was working with long thin needles of specially hard steel, carefully magnetised so that the only leakage of magnetism from the magnet might be as nearly as possible leakage in radiating tufts at the very ends. He practically had point-poles. When the only surface magnetism is at the end faces, the magnetic lines leak out like rays from a centre, in radial lines. Now the law of inverse squares is never true except for the action of points; it is a "point" law. If you could get an electro-magnet or a magnet, with poles so small in proportion to its length that you can consider the end face of it as the only place through which magnetic lines leak up into the air, and the ends themselves so small as to be relatively mere points; if, also, you can regard those end faces as something so far away from whatever they are going to act upon that the distance between them shall be large compared with their size, and the end itself so small as to be a point, then, and then only, is the law of inverse squares true. It is a law of the action of points. What do we find with electro-magnets? We are dealing with pieces of iron which are not infinitely long with respect to their cross section, and generally

\* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

\* See Ayrton's *Practical Electricity*, fig. 5a, p. 24.

possessing round or square end faces of definite magnitude, which are quite close to the armature; and which are not so infinitely far away that you can consider the polar face a point as compared with its distance away from the object upon which it is to act. Moreover, with real electro-magnets there is always lateral leakage; the magnetic lines do not all emerge from the iron through the end face. Therefore, the law of inverse squares is not applicable to that case. What do we mean by a pole, in the first place? We must settle that before we can even begin to apply any law of inverse squares. When leakage occurs all over a great region, as shown in this diagram, every portion of the region is polar; the word polar simply means that you have a place somewhere on the surface of the magnet where filings will stick on; and if filings will stick on to a considerable way down toward the middle all that region must be considered polar, though more strongly at some parts than at others. There are some cases where you can say that the polar distribution is such that the magnetism leaking through the surface acts as if there were a magnetic centre of gravity a little way down, not actually at the end; but cases where you can say there is such a distribution as to have a magnetic centre of gravity are strictly few. When Gauss had to make up his magnetic measurements of the earth, to describe the earth's magnetism, he found it absolutely impossible to assign any definite centre of gravity to the observed distribution of magnetism over the northern regions of the earth; that, indeed, there was not in this sense any definite magnetic pole to the earth at all. Nor is there to our magnets. There is a polar region, but not a pole; and if there is no centre of gravity of the surface magnetism that you can call a pole from which to measure distance, how about the law of inverse squares? Allow me to show you an apparatus (fig. 27), the only one I ever heard of in which the

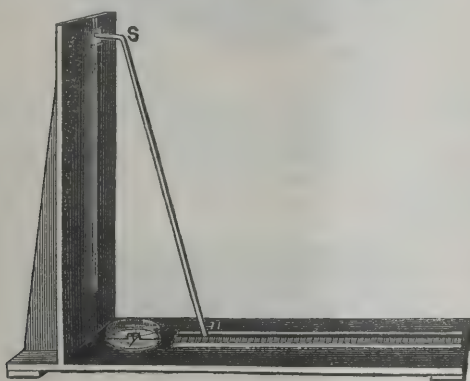


FIG. 27.

APPARATUS TO ILLUSTRATE THE LAW OF INVERSE SQUARES.

law of inverse squares is true. Here is a very long thin magnet of steel, about 3 feet long, very carefully magnetised so as to have no leakage until quite close up to the end. The consequence is that for practical purposes you may treat this as a magnet having point poles, about an inch away from the ends. The south pole is upwards, and the north pole is below, resting in a groove in a base-board which is graduated with a scale, and is set in a direction east and west. I use a long magnet, and keep the south pole well away, so that it shall not perturb the action of the north pole, which, being small, I ask to be allowed to consider as a point. I am going to consider this point as acting on a small compass needle suspended over a card under this glass case constituting a little magneto-meter. If this were properly arranged in a room free from all other magnets, and set so that that needle shall point north, what will be the effect of having the north pole of the long magnet at some distance eastwards? It will repel the north end and attract the south, producing a certain deflection which we can read off; reckoning the force which causes it by calculating the tangent of the angle of the deflection. Now, let us move the north pole (regarded as a point) nearer or farther, and study the effect. Suppose we halve the distance from the pole to the indicating needle, the deflecting force at half the distance is four times as great; the force at double the distance is one quarter as great. Wherefore? Because, firstly, we have taken a case where the distance apart is very great compared with the size of the pole; secondly, the pole is practically concentrated at a point; thirdly, there is only one pole acting; and, fourthly, this magnet is of hard steel, and its magnetism in no way depends on the thing it is acting on, but is constant. I have carefully made such arrangements that the other pole shall be in the axis of rotation, so that its action on the needle shall have no horizontal component. The apparatus is so arranged that whatever the position of that north pole, the south pole, which merely slides perpendicularly up and down on a guide, is vertically over the needle, and therefore does not tend to turn it round in any direction whatever. With this apparatus one can approximately verify the law of inverse squares. But this is not like any electro-magnet ever used for any useful purpose. You do not make electro-magnets long and thin, with point poles a very large distance away from the place where they are to act; no, you use them with large surfaces close up to their armature.

There is yet another case which follows a law that is not a law of inverse squares. Suppose you take a bar magnet, not too long,

and approach it broadside on towards a small compass needle, fig. 28. Of course, you know as soon as you get anywhere near the compass needle it turns round. Did you ever try whether the effect is inversely proportional to the square of the distance reckoned from the middle of the compass needle to the middle of the magnet? Do you think that the deflexions will vary inversely with the squares of the distances? You will find they do not. When you place the bar magnet like that, broadside on to the needle, the deflexions vary as the cube of the distance, not the square.



FIG. 28.

DEFLEXION OF NEEDLE CAUSED BY BAR MAGNET BROADSIDE ON.

Now, in the case of an electro-magnet pulling at its armature at a distance, it is utterly impossible to state the law in that misleading way. The pull of the electro-magnet on its armature is not proportional to the distance, nor to the square of the distance, nor to the cube, nor to the fourth power, nor to the square root, nor to the three-halft root, nor to any other power of the distance whatever, direct or inverse, because you find, as a matter of fact, that as the distance alters, something else alters too. If your poles were always of the same strength, if they did not act on one another, if they were not affected by the distance in between, then some such law might be stated. If we could always say, as we used to say in the old language, "at that pole," or "at that point," there are to be considered so many "units of magnetism," and at that other place so many units, and those are going to act on one another; then you could, if you wished, calculate the force by the law of inverse squares. But that does not correspond to anything in fact, because the poles are not points, and further, the quantity of magnetism on them is not a fixed quantity. As soon



FIG. 29.—CLOSED MAGNETIC CIRCUIT.

as the iron armature is brought near the pole of the electro-magnet, there is mutual interaction; more magnetic lines flow out from the pole than before, because it is easier for magnetic lines to flow through iron than through air. Let us consider a little more narrowly that which happens when a layer of air is introduced into the magnetic circuit of an electro-magnet. Here we have (fig. 29) a closed magnetic circuit, a ring of iron, uncut, such as that on which we experimented last week. The only reluctance in the path of the magnetic lines is that of the iron, and this reluctance we know to be small. Compare fig. 29 with fig. 30, which represents a divided ring with air gaps in between the severed ends. Now air is a less permeable medium for magnetic lines than iron is, or, in other words, it offers a greater magnetic reluctance. The magnetic permeability of iron varies as we know both with its quality and with the degree of magnetic saturation. Reference to Table III. shows that if the iron has been magnetised up so as to carry 16,000 magnetic lines per square centimetre, the permeability at that stage is about 320. Iron at that stage conducts magnetic lines 320 times better than air does; or air offers 320 times as much reluctance to magnetic lines as iron (at that stage) does. So then the reluctance in the gaps to magnetisation is 320 times as great as it would have been if the gaps had been filled up with iron. Therefore, if you have the same magnetising coil with the same

battery at work, the introduction of air-gaps into the magnetic circuit will, as a first effect, have the result of decreasing the number of magnetic lines that flow round the circuit. But this first effect itself produces a second effect. There are fewer magnetic lines going through the iron. Consequently, if there were 16,000 lines per square centimetre before there will now be fewer—say only 12,000 or so. Now refer back to Table III., and you will find that when  $B$  is 12,000 the permeability of the iron is not

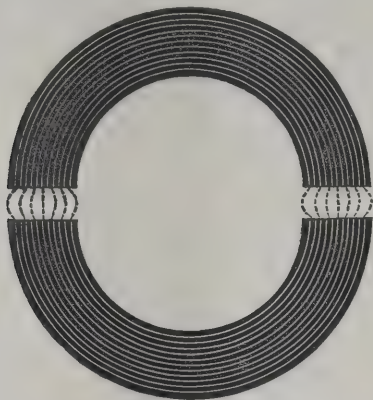


FIG. 30.—DIVIDED MAGNETIC CIRCUIT.

320 but 1,400 or so. That is to say, at this stage, when the magnetisation of the iron has been pushed only so far, the magnetic reluctance of air is 1,400 times greater than that of iron, so that there is a still greater relative throttling of the magnetic circuit by the reluctance so offered by the air-gaps.

Apply that to the case of an actual electro-magnet. Here is a diagram, fig. 31, representing a horseshoe electro-magnet with an armature of equal section in contact with it. The actual electro-magnet for the experiment is here on the table. You can calculate

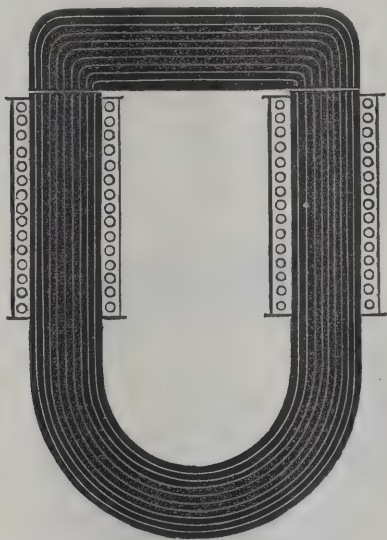


FIG. 31.—ELECTRO-MAGNET WITH ARMATURE IN CONTACT.

out from the section, the length of iron, and the table of permeability, how many ampère turns of excitation will produce any required pull. But now consider that same electro-magnet, as in fig. 32, with a small air gap between the armature and the polar faces. The same circulation of current will not now give you as much magnetism as before, because you have interposed air gaps; and by the very fact of putting in reluctance there the number of magnetic lines is reduced.

Try, if you like, to interpret this in the old way by the old notion of poles. The electro-magnet has two poles, and these excite induced poles in the opposite surface of the armature, resulting in attraction. If you double the distance from the pole to the iron, the magnetic force (always supposing the poles are mere points) will be one quarter, hence the induced pole on the armature will only be one quarter as strong. But the pole of the electro-magnet is itself weaker. How much weaker? The law of inverse squares does not give you the slightest clue to this all-important fact. If you cannot say how much weaker the primary pole is, neither can you say how much weaker the induced pole will be, for the latter depends upon the former. The law of inverse squares in a case like this is absolutely misleading.

Moreover, a third effect comes in. Not only do you cut down the magnetism by making an air-gap, but you have a new consideration to take into account. Because the magnetic lines, as they pass up through one of the air-gaps, along the armature down the air-gap at the other end, encounter a considerable reluctance, the whole of the magnetic lines will not go that way; a lot of them will take some shorter cut, although it

may be all through air, and you will have some leakage across from limb to limb. I do not say you never have leakage under other circumstances: even with an armature in apparent contact there is always a certain amount of sideways leakage. It depends on the goodness of the contact. And if you widen the air-gaps still further, you will have still more reluctance in the path, and still less magnetism, and still more leakage. Fig. 33

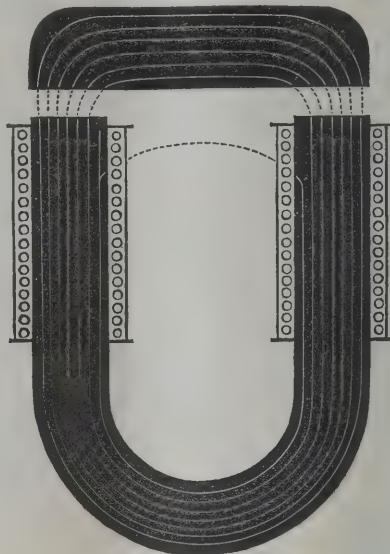


FIG. 32.

ELECTRO-MAGNET WITH AIR GAP ONE MILLIMETRE WIDE.

roughly indicates this further stage. The armature will be far less strongly pulled, because, in the first place, the increased reluctance strangles the flow of magnetic lines, so that there are

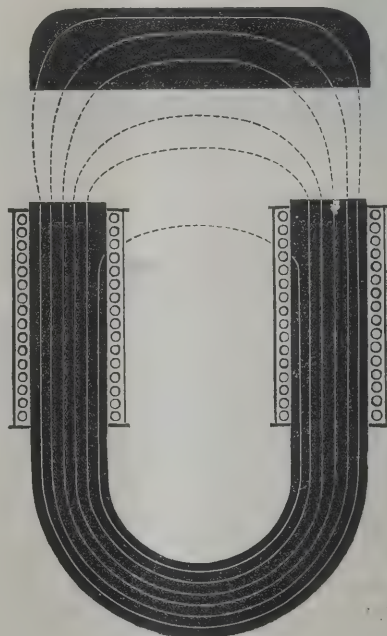


FIG. 33.

fewer of them in the magnetic circuit; and, in the second place, of this lesser number only a fraction reach the armature because of the increased leakage. When you take the armature entirely away, the only magnetic lines that go through the iron are those that flow by leakage across the air from the one limb to the other. This is roughly illustrated by fig. 34, the last of this set.

Leakage across from limb to limb is always a waste of the magnetic lines, so far as useful purposes are concerned. Therefore it is clear that, in order to study the effect of introducing the distance between the armature and the magnet, we have to take into account the leakage; and to calculate the leakage is no easy matter. There are so many considerations that occur as to that which one has to take into account that it is not easy to choose the right ones and leave the wrong ones. Calculations we must make by-and-bye—they will be added as an appendix to this lecture—but for the moment experiment seems to be the best guide.

I will, therefore, refer, by way of illustrating this question of leakage, to some experiments made by Sturgeon. Sturgeon had a long tubular electro-magnet made of a piece of old musket barrel of iron wound with a coil; he put a compass needle about a foot away, and observed the effect. He found the compass needle deflected about  $23^\circ$ ; then he got a rod of iron of equal length, and put it in at the end, and found that putting it in so

that only the end was introduced—in the manner I am now illustrating to you on the table—the deflection increased from  $23^{\circ}$  to  $37^{\circ}$ ; but when he pushed the iron right home into the gun barrel, it went back to nearly  $23^{\circ}$ . How do you account for that? He had unconsciously increased its facility for leakage when he lengthened out the iron core. And when he pushed the rod right home into the barrel, the extra leakage which was due to the

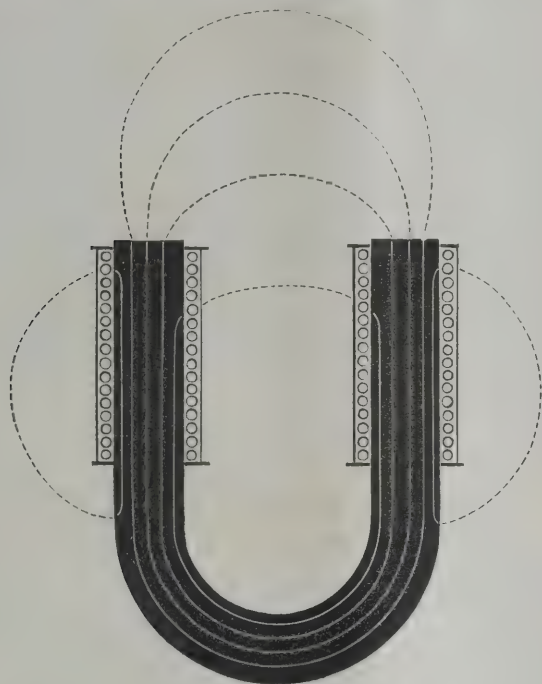


Fig. 34.

added surface could not and did not occur. There was additional cross section, but what of that? The additional cross section is practically of no account. You want to force the magnetism across some 20 inches of air which resists from 300 to 1,000 times as much as iron. What is the use of doubling the section of the iron? You want to reduce the air reluctance, and you have not reduced the air by putting a core into the tube.

(To be continued.)

## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—LEEDS, 1890.

### NOTES ON HIGH VACUA.

By J. SWINBURNE.

(Read before Section A, September 9th, 1890.)

#### I.

IN a series of papers on "Incandescent Lamp Manufacture," I called attention to the great superiority of the Geissler to the Sprengel form of mercury pump. Several kinds of Sprengel pump were successively connected to a Geissler, and both were worked at the same time. The Sprengel invariably stopped taking air down before the Geissler; in fact, the Geissler never stops. It acts as its own McLeod gauge, and never indicates a perfect vacuum. The probable reason why the merits of the Geissler have been so underrated is that it needs the greatest care in securing perfect dryness of the bulb and valve. Not only will traces of water vapour condense under the floating valve instead of lifting it and going through, but it is probable air does so too. About a century ago Davy showed that if the mercury were allowed to run up gently in an imperfect Torricellian vacuum, a bubble was left; but if allowed to rise suddenly, it indicated a perfect vacuum, the air being condensed against the glass. In the lamp papers I described a form of pump which avoids difficulties due to small condensations. The main bulb discharges into a small chamber sealed by a little V-tube, so that a pressure of  $1/100$  A would move the mercury. This chamber exhausts into a larger globe, exhausted mechanically, and sealed by a floating valve. The small chamber is thus as thoroughly exhausted as an ordinary pump can pump it; but the pump proper, exhausting into high vacuum, can thus work better. The condensed air and water cannot expand back into it. It is thus really a double pump, or two mercury pumps in series. The only drawback is that it needs some pressure to open the first valve or sealing, so that there might, after all, be some condensation under it. I have lately devised and used a pump made as follows:—A, is the body or chamber of the pump proper. This exhausts into the small chamber, B, sealed by the valve, C, and this exhausts into the chamber, G, sealed by the floating valve, H. G is connected to a reservoir and mechanical air pump.

The valve, C, has a long thin glass rod passing down through A into the lower tube, which acts as a guide. A loose sleeve, F, is strung on this rod. There is a swelling at E which fits the lower end of the sleeve, and is small enough to pass through the neck in putting the pump together. When the mercury rises in the globe, A, it lifts the sleeve till the lower end catches on E, which closes it. The mercury rises, and floats the sleeve, thus lifting the valve, C. The mercury that sealed C, then runs out, and there is a clear passage through into B; so no condensation takes place in A. The mercury rises till it floats H. When it falls, the valve, C, acts again, for the mercury has filled the sleeve, F, over the top, and C is heavy enough to sink the sleeve and rod when the sleeve is full of mercury. I have tried electromagnetic and other arrangements; but this is the best, as far as I have gone.

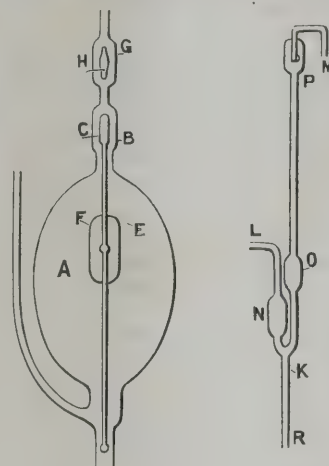


Fig. 1.

Fig. 2.

When using a pump it is best not to let air, and perhaps moisture, run through it more than can be helped. By the use of a sort of syphon it is possible to seal on new work to be exhausted without letting the air pressure into the pump.

The point, K, is the barometric height at which the mercury normally stands in the tube, R. There is then a clear passage between L, which is connected to the tubes to be exhausted, and M, which goes to the drying tubes and pump. When a tube has been sealed off and a new one is to be put on, the mercury reservoir at the foot of the arrangement is raised so that bulb, N, is filled. A tap at the foot of the tube, R, is closed, and the vacuum in L is broken. The mercury then runs up to the new barometric height, R. The new tube is then sealed on and exhausted by a mechanical pump, the connection being then sealed off. The mercury in the long tube then stands only half an inch or so above that in N, and on opening the tap at the foot of R, the communication is made again to the pump. The small bulb, O, and the trap at the top are to prevent a plug of mercury from going round into the phosphoric tubes.

The pump is driven by water so as to be self-acting, and can be left running for any length of time. Those who have worked much with mercury pumps will realise the value of this. Nothing makes one feel the futility of life more than to exhaust something by hand which cracks at the last stage, when five hours of life have been ticked off.

#### II.

IN the same papers on lamp making I urged, that [the methods of measuring high vacua were inaccurate and completely misleading. The McLeod gauge and the induction coil are usually relied on for testing vacua. In incandescent lamp work the induction coil is almost exclusively used. With the test by induction sparks, I have, at present, nothing new to add, and will confine myself to the McLeod gauge. In measuring vacua with this gauge it is assumed that the mercury itself has no vapour tension. The vapour tension of mercury has been given by Regnault as about 50 millionths of an atmosphere. If it is anything like this, of course a vacuum of one millionth, or of  $\cdot 005$  millionth, as some experimenters profess to have reached, is absurd. When discussing this subject at the Society of Arts after Dr. S. P. Thompson's well-known paper on "Mercury Pumps," Prof. Ramsay gave  $\cdot 25$  millionth of an atmosphere, or, as I shall write it shortly,  $\cdot 25$  m., as the vapour tension of mercury at ordinary temperatures.

The whole action of a pump is consistent with a vapour tension of from 25 m. to 50 m. A Geissler does not reduce the pressure in geometrical progression; but when it gets a good vacuum it takes out very little air each stroke, worked fast, and much more if worked slowly. This looks as if when the tension of mercury vapour was nearly reached, the air taken out at each stroke was what diffused into the mercury vapour. This would also explain why a Geissler, which goes on long after Sprengel stops, does not so readily make a sparkless tube. A Sprengel stirs up the mercury, and gives the tube being exhausted more chances of getting filled with mercury vapour, which is a non-conductor. This also explains why so many experimenters get better vacua with hot mercury. Of course a new pump should be heated to get the moisture off the glass, but not when it is in ordinary use.

To test this more directly, I attached two McLeod gauges to the same pump. They communicated till a fair vacuum was reached. One was then sealed by raising the mercury past the elbow tube. The gauges were allowed to communicate by lowering the mercury every now and then, and it was always lowered before taking a reading. By this arrangement, when the pressure was reduced nearly to the vapour pressure of mercury, one gauge might have little but mercury vapour, and show a good vacuum; while the other had air at the same pressure, and showed a pressure equal to the vapour tension of mercury, or nearly so. The gauges are graduated by finding  $p \cdot v$  corresponding to one millionth of an atmosphere, and graduating accordingly. The pressure in millionths is then the product of the reading on the closed tube and the difference in the column. Each reading is thus readily taken at several pressures to make sure there is no condensation of any vapours or gases. The readings obtained varied in an extraordinary way. When the exhaustion was carried so far that the open gauge registered 2 m. or 3 m., the closed registered from 20 m. to 60 m. The least difference in temperature seems to make a large difference in the readings. In some cases, when the vacuum was still low, the open gauge was heated till the mercury sputtered, and condensed about the bulb. The bulb was then warmed to evaporate the mercury and drive all the air out, and the elbow tube sealed by raising the mercury. When the gauge was cool both were unsealed and readings taken. The gauge that had been warmed sometimes gave 1 m. against no less than 230 m. in the other. Ten minutes' connection generally brought the readings equal. Obviously the movement of the air need not depend on diffusion only; for a very small difference of temperature would cause mercury to evaporate in one gauge and condense in the other, driving the air with it.

I made a gauge with an alloy of about equal parts of potassium and sodium, which is liquid at ordinary temperatures. It would, of course, absorb any mercury vapour, and has probably a low-vapour tension. It was very troublesome, for it could not be exposed to the air for a moment, and heavy hydrocarbons would prevent the pump's working. The alloy always gets some moisture, and gets coated with a thin film of oxide which prevents drops from uniting, and they can only be run together by heating under a hydrocarbon of low boiling point. I eventually got the gauge fitted up, but the alloy acted on the film of moisture on the glass, and the bubbles formed seemed to drive plugs of it about. It has a very low specific gravity, and pistons of it began to stray about inside the pump, and I was afraid they might get to the mercury, and by combining explosively, smash the pump, so the experiment was abandoned. In one experiment a plug did wander into the tube, &c., and cracked it.

Fusible alloy was next tried. It worked better, but the vapours of some sulphur that was used to trap any mercury vapour blackened the surface, and only two readings were obtained. These gave a pressure of only 13.5 m. as the vapour tension of mercury.

Whether it is really 13 m. or 50 m. is of comparatively little importance; but there seems to be quite enough evidence that the readings of .01 m., and higher vacua that have been given, are inaccurate to the extent of some hundreds of thousands per cent. This is important in many investigations pursued by means of mercury pumps, for instance, experiments on the "Fourth State of Matter." The question is also important in lamp making, as it shows that better vacua are possible, and they may be an advantage. I do not know whether pumps worked with alloy of sodium and potassium will come into commercial use.

#### DISCUSSION.

LORD RAYLEIGH considered the points that Mr. Swinburne had brought before the Section were of great interest. He had not had much experience in obtaining the highest vacua, but he had a good deal of experience with the mercury pump. He had been astonished with the immense quantity of vapour which hung about. At one time he passed a large quantity of air slowly over the mercury and then through a sulphur tube, and it would astonish most people to see what the discolouration of the sulphur was from the mercury vapour carried over the area. The points as to the behaviour of the McLeod gauge as the only available method for measuring the vacua were of the highest importance, and in conclusion he hoped Mr. Swinburne would not slacken his efforts to arrive at the bottom of the matter.

#### THE COMPENSATION OF ALTERNATING-CURRENT VOLTMETERS.

By J. SWINBURNE.

(Read before Section A, September 9th, 1890.)

In 1887 I had the honour of bringing before this Section several methods of compensating voltmeters and resistance-bridges for variations of temperature. Wires with different temperature co-efficients were used, by which means errors from change of temperature can be avoided. Methods of compensating wattmeters for the errors inherent in them were also explained. The present communication relates to a somewhat analogous arrangement for compensating alternating voltmeters for changes of frequency.

It is much more easy to make a current indicator for alternating than direct currents, for troubles from hysteresis do not come in, and the slight tremble makes the moving part hang freely. If it is attempted, however, to use such an instrument as a voltmeter, the self-induction makes the reading far too low, and the error varies with the frequency.

To get over this trouble, a voltmeter may have a non-inductive, or nearly non-inductive, resistance put in shunt to its active coil. A coil with an adjustable iron core is then put in shunt to the active coil, this shunt coil having a very much larger time-constant. Though both coils have iron cores, they have open magnetic circuits, so they have practically constant co-efficients of self-induction. When the frequency increases, the current through the whole instrument under a given pressure falls; but the back pressure of the shunt coil increases more rapidly than that of the active coil, so that it takes less than its share, while the active coil gets a larger share of the reduced current; the actual current, and therefore the reading, in it remaining constant. The instrument is calibrated with a direct current. An alternating current is then put on, and the core of the shunt coil regulated till the readings agree with those of the direct current.

A similar effect might be obtained by putting a condenser in shunt to the non-inductive series resistance; but it does not look so promising, and I have not gone into the size of condenser needed in practice.

#### LONDON COUNTY COUNCIL.

THE weekly meeting was held at Spring Gardens, S.W., on Tuesday last, with Sir John Lubbock in the chair. The Asylums Committee, in bringing forward their report, stated, with reference to the Claybury Asylum, it had been decided to light it by electricity. In order to do this, they had referred it to one of the assistants in the engineers department to prepare and formulate a scheme for that object. It would be necessary for the purpose to expend a sum of money for the preparation of plans, the employment of temporary draughtsmen, and, possibly, for consultation with an expert. In conclusion, the committee recommended that a certain sum of money should be devoted to the object.

#### NEW PATENTS—1890.

15413. "An arc electric lamp." T. B. GRANT. Dated September 29.

15455. "Improvements in or appertaining to welding metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated September 30. (Complete.)

15456. "Improvements in or appertaining to welding metals electrically." W. P. THOMPSON. (Communicated by C. L. Coffin, United States.) Dated September 30. (Complete.)

15464. "Apparatus for governing electric light engines, marine engines, and other engines." T. SULLIVAN, J. W. HUGHES, V. W. CHERMERY, and A. H. S. BROWNE. Dated September 30.

15469. "Improved method of, and apparatus for, administering electricity to the human body." O. IMRAY. (Communicated by the Bethel Electric Medical Baths Company, Limited, Australia.) Dated September 30. (Complete.)

15482. "Improvements in and relating to electric batteries." H. H. LAKE. (Communicated by the Crosby Electric Company, United States.) Dated September 30. (Complete.)

15547. "Improvements in locked switches for electric current circuits." J. A. LILFEE and F. TEAGUE. Dated October 1.

15573. "An improved method and means of attaching and suspending electric and other fittings." F. J. DOWN. Dated October 2.

15629. "Improvements in telephone transmitters and induction coils to be used therewith, and for other purposes." W. WHEATLEY and J. LEWIS. Dated October 2.

15640. "Improvements in electric or secondary batteries." E. HANCOCK and A. J. MARQUAND. Dated October 2.

15643. "Improvements in and connected with electric tramways or railways, and for working electrically propelled vehicles thereon." E. HOPKINSON. Dated October 2.

15644. "Improvements in electric clock-circuit-closing apparatus." W. BROWN. Dated October 2.

15654. "Improvements in pull-down switches for walls or ceilings for electric light." C. W. COX and F. ROBINSON. Dated October 3.

15741. "Electric fire indicator." T. R. DOUSE. Dated October 4.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS 1889.

10640. "Improvements in electric arc lamps." T. P. C. CRAMPTON and A. ESSINGER. Dated July 1. 8d. Claims:—1. In combination with the lower carbon holder tube, a crown piece at its top carrying several refractory studs, and a weight urging upwards a conoidal piece of insulating material supporting the carbon, so that the coned point of the carbon is retained in position as it is consumed by bearing against the studs, against which the conoidal insulating piece is made to bear when the carbon is exhausted, substantially as and for the purpose set forth. 2. In combination with the upper carbon holder tube having attached to it a core subject to the differential attraction of two solenoids, a clutch consisting of jaws which grip the carbon until, by the descent of the tube a certain distance, they meet adjustable stops whereby they are released, allowing the carbon to slip downwards, substantially as described. 3. The combination of a lower carbon holder such as is referred to in the first claim, and of an upper carbon holder and clutch such as is referred to in the second claim with suitable solenoids and framing, constituting an electric arc lamp, substantially as described.

12185. "An improved mode of and apparatus for distributing electricity." A. H. HOWARD. Dated July 31. 11d. Claims:—1. In a system of electric distribution from a central station, through storage batteries situated at various points on the external circuit, the use, at the central station, of a periodically acting automatic switching apparatus, for diverting (temporarily) the entire dynamo current from the batteries in charge, to a resistance, and allowing mechanism situated at the various storage stations on the line, to come into action and effect the changes in the local circuits, as and for the purpose above described. 2. In combination with the storage batteries at each installation, a rotary commutator arranged to effect a cycle of changes in the connection of the batteries with the line wire, and with each other, as and for the purpose above set forth.

12236. "Improvements in appliances for distribution of power by alternating and commutated electric currents." J. SWINBURNE. Dated August 1. 8d. Transformers are used to transform alternating currents, and these alternating currents are, when desired, combined to form direct currents, and may themselves be produced by the commutation of direct currents. 5 claims.

12237. "Improvements in and connected with electric transformers." J. SWINBURNE. Dated August 1. 8d. Two or more transformers are used for each house, and are put into or out of circuit by automatic gear as required. Thus a 100-lamp house may have a 90 and a 10-lamp transformer. The 10-lamp transformer is ordinarily in circuit, but when the current rises to that of 11 lamps, an electro-magnet or other suitable mechanism cuts the primary and secondary of the 90-light transformer into circuit. When no lamp is used the mechanism may be arranged to cut out even the 10-lighter, and leave in a minute transformer just big enough to work the mechanism. 5 claims.

12503. "Improvements in dynamo-electric machines." F. V. ANDERSEN. Dated August 7. 8d. Has for its objects to construct the brushes by which the current is taken off or conducted to a dynamo-electric machine of an improved shape and in an improved manner. The brushes are constructed in the shape of an arc of a circle, and are manufactured by winding copper or other wire, or conducting strips or tape, into a round reel, and soldering the wire or strips or tapes together at as many places as the number of brushes intended to be cut out of the reel, and, finally, cutting the reel into the intended number of pieces, so that a soldered portion is at or near one end of each piece, and the other end is unsoldered. The brushes are arranged in such manner that the end that comes in contact with the commutator is radial to it. 4 claims.

13553. "Improvements in and in connection with electrical signalling apparatus for preventing collisions between trains on railways." E. EDWARDS. (A communication from abroad by T. Verls, of Würzburg.) Dated August 27. 8d. This invention has for its object the prevention of collisions between locomotive engines or trains travelling in the same or opposite directions upon the same line of rails, and also to give notice at the right time of the threatening danger to the drivers of both locomotives by means of electrical bells. 3 claims.

## CORRESPONDENCE.

### Electricity Meters.

In your last week's issue under "Meters" in your Notes, I see with much interest that there are 515 electricity meters in use at the Geneva Central Station.

Permit me to say with regard to your concluding remark that I do not think it in the least doubtful that this total is largely exceeded in the London central stations. This company alone, for instance, has 206

electricity meters in daily operation, all of the Aron type, with one exception, and over 17,500 lights.

The Kensington and Knightsbridge Company, St. James's and Pall Mall, Westminster Company, and others will at least make the total reach 1,000, and to this would have to be added the meters on the alternating systems.

W. Howard Tasker,

Electrician Chelsea Electricity Supply  
Company, Limited.

October 21st, 1890.

In the last issue of your esteemed paper, on page 463, you mention under the heading "Meters," that 450 Aubert meters and 65 Aron meters are in operation at the Geneva Central Station. You conclude the leaderette with the question, "*We wonder whether London with all its central stations can total 515 meters in use?*"

Will you allow us to draw your attention to the fact that the Aubert meter is not an electricity meter like the Aron meter, but simply a primitive arrangement for counting the "lamp hours," consequently it does not come up to the standard which is expected in this country for meters.

As regards the number of meters in use in London, we cannot say positively how many meters of the various types are in actual use, but it may interest you to know as a positive fact that we have sold the following number of Aron meters:—

For the year 1887	...	...	...	26
" " 1888	...	...	...	69
" " 1889	...	...	...	354
" " 1890 up to date	...	...	...	721

And we have booked orders within the month of October for close on 1,100 Aron meters to be delivered during the coming season, most of which are for London.

The General Electric Company, Limited.

H. HIRST, Director.

### The Lane-Fox Patents.

Now that "The Lane-Fox Electrical Company" is showing some fresh signs of vitality by bombarding the unfortunate "consumers" of electric light with mysterious manifestoes, threats of writs, *et hoc genus omne*, it would be useful, I think, if some of your more initiated readers would throw a little light upon this matter. Many good people, I fancy, have either forgotten Mr. Lane-Fox and his inventions, or are now hearing of them for the first time. Upon such minds the question "What is the Lane-Fox system?" has very much the same effect as the old riddle, "Who's Griffiths?" with which in my early youth the walls and hoardings of London used to be placarded. Is Mr. Lane-Fox also the Safe Man?

Mystified.

October 22nd, 1890.

### Running Alternators Parallel.

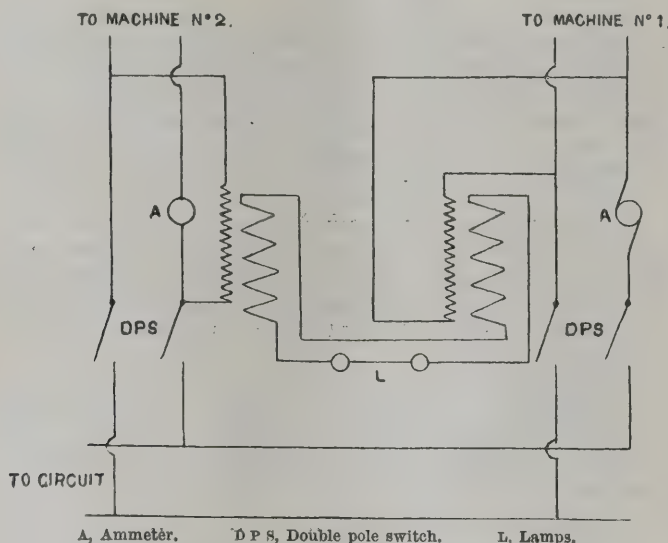
It may interest your readers to know that during the past few days we have tried running the Mordey alternators here in parallel. The results have been in every way satisfactory.

As we had no synchroniser, we joined a transformer to each of the two machines, and put the secondaries in series with two incandescent lamps, so that when the two machines were in phase, the lamps were bright as with an ordinary synchroniser. We tested the transformers for this by so connecting them both to one machine, that the lamps in series were bright with the secondaries in series. We then transferred the primary wires of one transformer, so as to connect it to the corresponding poles of the other machine,

We send you sketch of the connections. From these you will see that any current passing from one machine to the other is registered on both ammeters.

The machines were first put parallel when the load on the one supplying current to the outside circuits was only 5 ampères. They went into step at once and kept so. The current going between the machines to keep them in phase was not sufficient to make the needles swing more than 2 ampère divisions on the ammeters.

The load was transferred to either machine quite easily by speeding its engine up slightly by means of its governor.



The second dynamo was switched out of and into circuit several times as the current increased. They were run parallel till after the heavy load of the evening (about 40 ampères) was passed, each machine taking half the work.

During the heavier loads, the swing of the needles was greater, showing that more current was being sent between the machines; but this would correspond to only 3 or 4 ampères.

When the load dropped under 30 ampères, the load was transferred to one dynamo, and the other switched out of circuit.

We have also made the experiment of switching the machines in parallel when not at the same voltage. The difference was about 3 per cent. The current which flowed between them was 10 ampères. This seems to indicate that a very large current indeed must have passed when Mr. Mordey made his experiment of putting a machine at 1,000 volts in parallel with one at 2,000 volts.

George S. Hooker, *Electrician.*

Bath Electric Light Works,  
October 15th, 1890.

#### Accumulator Management.

Will Mr. Barber-Starkey kindly oblige by letting me know how much soda (common washing, I believe) should be put to one gallon of solution—1 to 10 for accumulators. I have lately bought some second-hand cells. Some give a good current after charging and others comparatively little, though all look much the same in colour. What is likely to be wrong, and how can I remedy it?

I have already tried some soda, adding it to the solution, which hissed up until it was dissolved; but considerable sulphate still remains.

B. B.

#### Telephonic Specific Inductive Capacity.

In an article under the above heading in your last issue, Mr. W. W. Jacques points out that there is a considerable difference between the telephonic and the

telegraphic specific inductive capacity of certain materials.

After describing some experiments made by himself and others upon various dielectrics, he gives a table showing that the telephonic capacity of all the samples tried, except one, is HIGHER than the telegraphic capacity of those samples.

Surely this is not quite correct.

All theory and practice, except Mr. Jacques's, so far as I am aware, tend to show that the capacity of any dielectric is LESS when measured by currents of short duration—*e.g.*, telephonic currents—than when measured by currents of longer duration, *e.g.*, telegraphic currents, owing to the "absorption effect" noticeable when any dielectric is charged for an appreciable time.

This is clearly explained in most text-books upon the subject, and is noticed even in the authority quoted by Mr. Jacques, *viz.*, "Gordon's Electricity and Magnetism," chapter 11. On pages 99 and 103 of the second edition, experiments are described and figures given which clearly show that Mr. Jacques's deductions are not correct.

Again, on page 109, we read: "*The capacity increases if the electrification is continued—at first rapidly, then more slowly,*" &c.

As the question is of considerable importance in long distance telephony, and, as an earlier edition of the same article has been published in your Journal of 21st March last, page 314, without any one drawing attention to the inaccuracy of the results contained therein, I think an explanation is due from Mr. Jacques as to how his experiments were made, and also as to how he arrives at the "calculated results" given in the middle column of the table referred to.

J. W. Ullett.

October 21st, 1890.

On 28th March last you were good enough to publish a letter from me on the subject of telephonic specific inductive capacity, and in your Editorial columns you remarked that when Dr. Jacques had read the letter you would probably receive a disclaimer from him. The article by Dr. Jacques quoted in your last week's number from the New York *Electrical Engineer* is mainly a republication of the communication which I criticised, but with the omissions I claimed should be made. It seems to me that the article contains internal evidence that Dr. Jacques has read my letter, but I have not noticed any disclaimer in your columns.

Perhaps another reminder would bring it about.

J. E. Kingsbury.

October 21st, 1890.

#### Accumulator Explosions.

Having read the account of the extraordinary accident which took place on board Earl Poulett's steam yacht, the *Pathfinder*, I think the occurrence, though fortunately uncommon, may be easily accounted for on the supposition that during the violent storm of rain when the leak was reported, water must have collected somewhere near the main conductors, or some uninsulated portion of the system, and have been decomposed, liberating hydrogen; and a sufficient quantity of this gas, in conjunction with the atmospheric air would naturally and immediately explode on a light being struck. Therefore this mishap need in no way be attributed to the use of accumulators, as it seems they were properly ventilated, and such accidents may be readily prevented by taking care to duly protect and insulate the flow and return conductors, and other exposed portions of the system from each other.

H. Edmunds.

October 21st, 1890.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## THE LANE-FOX PATENTS.

IN our present issue we print a somewhat lengthy letter from Mr. St. George Lane-Fox; but we fail to see that he has answered the various points that we raised. We think that he passes too lightly over the demonstrations and work of others previous to 1878, the date of his first patent, and although these experiments may have been mainly with lamps made of platinum wire or strip, yet that would not alter the principle of running such lamps in parallel or series, as might be desired, there being no invention in the arrangement. For such modifications would have occurred to anyone who was studying the subject; and as two horses might be driven either abreast or in tandem, so lamps might be connected up either in series or in parallel arc. Long before Mr. Lane-Fox commenced his researches, it was a common practice to connect up primary batteries in series for tension, and in parallel arc for quantity, and therefore the principle of such arrangements were well-known to electricians. Prof. Moses G. Farmer, in discussing his experiments at Salem, Mass., in 1859, remarks:—

“If a wire of pure platinum 5 inches long and  $\frac{1}{160}$ th of an inch in diameter be traversed by a current of electricity, somewhat more than five and less than six vebers in strength, it can be maintained at a temperature quite near to the point of fusion, and while in this condition it will, in the common atmosphere, emit something more than three candle lights, and just below the melting point, the light will be between four and five candle lights.

“Now, if 100 such wires be put in series in a circuit, the sum of this resistance would be 125 ohms, and it would require a difference of potential equal to  $125 \times 5\frac{1}{2} = 687\frac{1}{2}$  volts to maintain this strength of current of  $5\frac{1}{2}$  vebers, and we should get in the aggregate 500 or more candle lights.”

Mr. Lane-Fox may object that this only refers to the running of lamps in series, and the maintenance of current for that purpose. But mark what follows:—

“If, further, we should arrange 10 such circuits in multiple arc, having 100 lights in each of the 10 branches, we should find the joint resistance of this part of the circuit reduced to  $12\frac{1}{2}$  ohms; but it would now require a current of 55 vebers’ strength to keep the lamps all shining and the difference of potential required to maintain the 1,000 lights, each from three to five candles, would still be  $687\frac{1}{2}$  volts; but we should now have 5,000 candle lights instead of 500.”

Therefore, it is quite evident that the laws which govern the running of incandescent lamps in parallel were clearly recognised many years before the advent of Mr. Lane-Fox.

With regard to the *only* claim for which Mr. Lane-Fox says he is now endeavouring to obtain recognition (*viz.*, for a system of combining incandescent lamp distribution in multiple arc at a constant potential, with secondary batteries as reservoirs of electrical energy); if this patent entitles him to the combination with a reservoir, why is he not entitled to the running without a reservoir? This would mean that any mode of running two or more lamps in parallel, whether from dynamos, accumulators, or thermopiles, would be included in his system. On the other hand, it would seem that the addition of the battery was the invention that Mr. Lane-Fox claims, and therefore he might as well claim the discharge from the battery as distinct from the dynamo. As, however, he does not go into details, and ignores the work of earlier pioneers, we can hardly call his methods discoveries or inventions, as they were simply the obvious arrangement of parts, the parts themselves being the patentable matter, and not their re-arrangement.

One thing, however, is quite clear: secondary batteries can still be used without infringing Mr. St. George Lane-Fox’s claim if employed for discharging when disconnected with an operating dynamo. On this point some doubt has been expressed, but we have it from the inventor himself that it is only when used simultaneously with a dynamo that he makes any demur, for it is well known that Werdermann con-

nected his lamps up in parallel arc, the potential being constant, or as nearly so as was possible with the machine employed to generate the current.

With regard to the Brush Company, they would naturally have no interest in contesting the validity of Mr. Lane-Fox's patents while they held them; and when they were relinquished the Brush Company retained the right of working under them, so that any license granted under those circumstances would only be a matter of form, and could not be construed as a surrender to Mr. Lane-Fox's claims.

Why should Sir David Salomons be quoted? He simply shows that primary batteries, as usually made, have so high an internal resistance that any alteration in the work they are doing causes a variation of their potential. With a very large battery, however, the internal resistance would be small in proportion, so that less variation would be apparent. But the term "constant potential" is only a comparative one, and, should the work the battery is doing be out of proportion to its size, the potential would again be irregular, as in a primary battery. Thus it is wholly a question of proportioning batteries to their work, whether they be primary or secondary.

We have every desire to set the views of the contending parties clearly and fairly before our readers, and for this purpose we feel ourselves justified in asking Mr. Lane-Fox for a further explanation and a reply to our remarks of last week.

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## FOR ELMORE SHAREHOLDERS.

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IN bringing our articles on the Elmore Companies to a conclusion, we may remind our readers that we were somewhat sceptical when the first companies were issued, but it was hardly possible to foresee the later developments. Company following company naturally aroused our suspicions, and we protested, as we were bound to do. The results of our enquiries on the various points are before our readers, and speak for themselves, so that we need not say whether we consider our suspicions to have been confirmed or not.

We know that the promoting instinct is prone to follow up an initial success with ventures of the same kind, and the success of the first company was a temptation to repeat the operation which could not, apparently, be resisted. The issue of the Austro-Hungarian prospectus has been the last, and though there is little room for doubt that there were more to follow, it is satisfactory to know that no other has since been issued. We have no exaggerated idea of our contribution to this result. We do not anticipate that our electrical friends are amongst those who would rush in for Elmore shares, and the general public do not read technical papers, or seek in them information upon topics which come within their province. All the same, we have felt it to be our duty to speak out for the benefit of any investor whom per-

chance our words might reach, and for the credit of the electrical profession.

We have spoken out, and having done so we will say nothing more of the past, but deal with the present and the future.

To the shareholders of the subsidiary companies we venture to repeat the advice which we gave before. Keep the money you have in hand, and don't proceed with the work set out for you until the parent company has shown that there is a commercial success in the Elmore process. There is nothing unreasonable in this. All that will be lost is time, and that can be made up with the good start which the experience of the parent company will give you. There is no reason to suppose that France and Austria are so hungry for Elmore copper that by a few months' delay a market may be lost never to be regained. Energy, enthusiasm and enterprise are very well in their way but we recommend a strong infusion of caution as well.

To the shareholders of all the companies we would say: Remember that it is not an unusual thing for a company to embark in an enterprise with which it is found undesirable to proceed, and thereupon to take up something else. Articles of association are wide enough to permit very varied occupation for the employment of the capital subscribed. Sometimes this diversion leads to success, but too often it means that, however little the directors know of the business for which the company was originally formed, they know less about the second string, with the result that disaster comes at last.

To the parent company, we would say: You have received valuable consideration for the rights with which you have parted, and it is your duty to carry the process to a successful conclusion if you can, but not necessarily to throw good money after bad if your expectations of a Golconda show unmistakeable signs of being misplaced.

Inventors are expected to be sanguine, but to the promoters more than the usual responsibility attaches, on account of their well-known connection with the electrical business, and the pledges which they have given that their thorough examination of the system had satisfied them of its value.

Of the process itself we have written with the best information at our disposal, and, in considering that information, have used our best judgment. We shall, if proved to be wrong, cheerfully withdraw any unkind things we may have said about it. But successful or not successful, we shall not alter our opinion of the un wisdom of floating a series of companies and paying away large sums of money for an undeveloped and comparatively unprotected process whatever its problematical prospects.

To electricians the electro-deposition of copper on a large scale is in itself a matter of considerable interest. To a number of subscribers understanding the risk they run and being prepared for either success or failure, and the inventor depending on results for his remuneration, it would have been a legitimate enterprise; we could then have encouraged it and watched with interest the results attained,

The Labour  
Question.

WE mentioned in a former number that our rules respecting anonymous correspondence compelled us to deny admission to our columns of a letter signed "S. T. E.," purporting to be a reply to our article of October 10th, on the labour question. But so that "S. T. E." may not be under the apprehension that the waste paper basket has been the destination of his letter, we will devote a few words to a brief review of the contents of his communication. In the course of a somewhat rambling series of assertions and contradictions, making it uncertain whether "S. T. E." upholds the conduct of the unionist or appeals on behalf of the working man in general, our correspondent upbraids us with having employed the epithets "bully," "sneak," and "perverter of the truth," as being descriptive of the general characteristics of the unionist. We would refer "S. T. E." to the history, as recorded in the police courts and hospitals, of every strike which has taken place, and would then ask him if the conduct of unionists and the treatment of non-unionists, do not emphatically bear out the justice of our language. Our correspondent in the all engrossing desire to support the cause of those with whom he sympathises, lends his own voice to swell the war-whoop of "capital *versus* labour," and indulging in a diatribe against capitalists, so heats his fancy, that he entirely misses the whole point and intent of our article, which certainly did not make the question one of class *versus* class, an issue which "S. T. E." would apparently provoke. "S. T. E." censures our expression of opinion as being "unavailing and harmful," "as it is generally false." He does not, however, attempt to support this contention by either argument or evidence, but pretends to find, in the action of employers to maintain the rights of free labour, an evidence of the tyranny of capital over labour, and a palliation of ill-advised and ill-directed proceedings. From the general tone of the communication we should guess the author to be a well-meaning, but very young, enthusiast. Some further study of the subject may, however, show him that indiscriminate strikes must result not only in a loss to the employer, but eventually in much graver consequences to the workman; and he may learn that the attempt to coerce either capital or labour, must end in disaster to all classes of the community.

## Bahamas Cables.

THE rapidity with which news is now-a-days diffused is marvellous, and in no less degree have we cause to wonder at the extraordinary fertility of invention evidenced in the contents of the daily journals. It is a common enough event to read very exact particulars of occurrences, when the persons who are presumably most interested, are entirely ignorant of their having taken place. We extract the following from the *Evening News and Post*:—"That so important a colony as the Bahamas should be unconnected by cable with the rest of the world is a singular fact. Quite recently the neighbouring colony of Bermuda has obtained a cable, but at the almost prohibitive tariff of 4s. 2d. per word. Better things have been done for the Bahamas, as we understand on good authority that the India-rubber and Telegraph Works Company of Silvertown, are about to lay a cable from Jebrida to Nassau Bahamas, at the cost of £25,000, and that the money for this cable is being provided by the colony. The charge per word for England will be 2s. per word, with a half extra for official telegrams and a reduction for press news. The rate to America will be 6d. per word. The cable will be ready for use by the spring."

## A Quiet Rubber.

A CORRESPONDENT, who signs himself "Perplexed," sends us some circulars descriptive of the Bellhouse Patent Anti-Rheumatic Towel. The peculiarity of the towel is, that it is made from a fibre which generates electricity, but, unlike other known fibres, which absorb what they produce, that of "the anti-rheumatic towel, having a negative power, compels the body to absorb the electricity it generates from the part on which it operates." That a good rubbing with a friction towel is invaluable as a specific for rheumatic complaints is undoubted, but why the virtues of this particular toilet appliance should be attributed to a negative electrical power in the fibre we do not quite comprehend. Though the electrical explanation is utter rubbish and results either from ignorance, or intention to foist on the public by investing it with fictitious attributes an everyday appliance, it is quite possible that the rheumatic victim may be induced to rub harder with this towel inspired by the desire to see sparks or feel an electrical glow, whatever that may be. This would amply account for its efficacy and also throw light on the testimonials written in its favour by men of position and undoubted integrity. Imagination has much to do with these things; the old towel is played out and it offers but small inducement to rub; but make a man believe he is a sort of animated frictional machine and the influence is at once apparent. It acts like a charm and he rubs with tenfold vigour. Truly electricity is a name for both ignorant and enlightened to conjure by.

Lighthouse  
Illuminants.

THE recent report by Sir C. G. Stokes, Lord Rayleigh, and Sir W. Thomson on the subject of lighthouse illuminants seems to be somewhat contradictory to opinions which have been previously expressed by other observers as regards the efficiency of the electric light. It has been stated that, although in clear weather the electric light is far superior to gas or oil, yet in fog and haze it has but very little penetrating power, and that in such cases the glare of the large mass of flame from oil or gas can be seen when the electric light has wholly disappeared. The report in question, however, states that when the electric light has been deprived in great measure of the highly refrangible rays, in which it so much abounds, by passing through a sufficient length of haze, in its further progress it is not more cut down than the light from gas or oil, and the initial intensity is so great, that it still retains its superiority. Accordingly, the signatories to the report, in their conclusions, state that the experiments establish the superior power of the electric light as exhibited at the South Foreland under all conditions of weather, &c.

## The Microphone.

THE exact action of the microphone has never been really satisfactorily explained, although theories and experiments innumerable were for several years in succession brought forward to solve the mystery of its phenomena. Of late years little or nothing has been done in the matter, the all-absorbing interest in the electric light and its allied industries having diverted the stream of experimental and theoretical work. In a recent paper read before the American Academy of Arts, Prof. Charles R. Cross gives the results of experiments he has made relative to the "Extent of the Excursion of the Electrodes of a Microphone Transmitter." The method adopted for the researches was a stroboscopic one, a microscope magnifying up to 940 diameters being used. The greatest movement observed, consistent with good quality tones being obtained, was  $40 \times 10^{-6}$ . Interesting as the paper is, it still leaves us in the dark as to the way in which the movement of the electrodes causes a resistance variation.

ON THE EXTENT OF THE EXCURSION OF  
THE ELECTRODES OF A MICROPHONE  
TRANSMITTER.\*

By CHARLES R. CROSS, Thayer Professor of Physics.

THE character and extent of the motions of the electrodes of a microphone transmitter, when actuated by sound waves of different degrees of intensity, is a subject in telephony of by no means slight importance, but to which very little study has been given. The present paper describes the results of some observations relating to this subject, which have been made at various times during the past two years.

Several years ago an attempt was made by Mr. W. W. Jacques and the writer to gain some knowledge as to the amplitude of the vibrations of the hammer electrode of a microphone, by observing it with a microscope while in operation, and noting the extent of the blurred portion of the image. The results, though giving all that could be expected from so crude a method were not very satisfactory so far as definite measurement was concerned.

It afterwards occurred to the writer that the matter might be studied more completely by the use of the stroboscopic method, and an arrangement of apparatus was adopted by which the motions of the electrodes could readily be observed.

This was done in the following manner. The microphone to be studied was placed in the field of a microscope, whose line of collimation was horizontal. Behind the microphone, at a suitable distance, was placed a Helmholtz mercury interrupter, with a tuning fork making 128 vibrations per second. The extra current due to the electromagnets of the interrupter was quite large, so that a brilliant spark was obtained at each rupture of the circuit, as the platinum style of the interrupter left the mercury. The interrupter being properly placed, and the light of the spark concentrated by a lens, quite a bright field was obtained, against which the electrodes were seen projected, as silhouettes. The light, though intermittent, of course seemed continuous, since the sparks were so numerous. When good definition was obtained, the microphone was set in operation, usually by means of an organ pipe placed at a convenient and variable distance, and in some experiments by the voice. The pipe was blown by a constant blast, and great uniformity of intensity in the sound was secured. An open C<sub>3</sub> organ pipe making approximately 256 double vibrations per second was commonly used, its pitch being variable to a moderate extent by shading the mouth or the opening at the top.

So long as the pipe was an exact octave in pitch above the interrupting fork, the electrodes of the microphone as seen with the microscope appeared to be at rest; but if the interval was slightly disturbed, the stroboscopic effect was observed, and the electrodes seemed to move slowly through their complete course. The rate of this apparent vibration was of course dependent upon the deviation of the pipe from exactness in its interval with the fork, and could be varied at will within quite wide limits.

The extent of the motion of the electrodes could be determined by observing the grains of dust which adhered to them, or some definitely marked roughness on their surface. Measurements were made by means of a spider-line micrometer, the wires of which were placed at a convenient distance apart, and the amplitude of the motions of the selected points of reference on the microphone was determined by estimating the relation of their apparent motion to the distance separating the wires of the micrometer. This last distance was frequently varied to diminish the liability to error from a possible bias of the observer towards an agreement with earlier results.

In the experiments described in the present paper,

the electrodes were generally so adjusted that the motion of the anvil electrode was too small to be observed. Under these circumstances the observed motion of the hammer electrode, as measured by the micrometer, was the motion of this relatively to the anvil electrode, which is of course the quantity to be determined, rather than the actual excursion of the hammer electrode.

The microphone was placed in circuit with a battery and the primary of an induction coil, whose secondary contained a receiving telephone. With this arrangement the effect on the ear of the electrical variations due to the various values of the excursions of the electrodes could readily be observed. In many cases a second observer was stationed at the receiving telephone, which was then placed in a separate room.

Magnifying powers were used of from 50 to 1,000 diameters. With the higher powers the use of an objective of short focal length was difficult on account of the small working distance, so that, although even as short a focus as  $\frac{1}{10}$ th in. was sometimes employed, it was found much preferable to obtain the needed magnification by the use of short focus eye pieces.

The brilliancy of the electric spark was amply sufficient for illumination of the field, even with the highest magnification employed; a fact which calls attention vividly to the enormous "instantaneous intensity" (so to call it) of that light. Considering the excessively brief duration of the spark and the very small quantity of matter illuminated, it seems unquestionable that the intrinsic brilliancy is far greater than that of the electric arc, a view fully supported by the results of spectroscopic study.

Various forms of microphone were observed, but the general features characterising the actions studied were common to them all. As the intensity of the sound acting on the microphone was increased by approaching the organ pipe to the diaphragm, the motion of the hammer electrode, at first absolutely invisible, was seen gradually to increase, until, when the intensity was very great, the motion was excessive, the anvil electrode being violently pushed aside, and the hammer leaving it on its return motion, so that the circuit was broken at every vibration. At the same time bright sparks were seen between the electrodes. To the ear the simultaneous acoustic changes in the sound transmitted were very striking. The sound of the pipe was distinctly audible, and its quality clear, with motions of the hammer electrode far too slight to be observable. As the sound actuating the telephone became louder, and the excursion of the electrode became visible, the quality continued good, the sound transmitted growing louder; and then, as the excursion increased further, the quality gradually changed, shrill false notes made their appearance, and the sound began to grow harsher, until finally, when breaks appeared in the current, the sound was excessively harsh, and entirely devoid of musical quality. Long before this, however, the characteristic quality of the organ pipe disappeared.

The following tables will illustrate the results obtained. In making many of the measurements I worked in company with Mr. W. W. Jacques, whose observations were always in substantial accord with my own. A large number of observations have also been made, under my direction, by Messrs. A. W. Jones and F. L. Dame, students in the laboratory, whose work has been performed with conscientiousness and accuracy.

The microphone used in most of the experiments was one in which the anvil electrode was a "pendulum electrode," suspended by a vertical rod, hinged at the top, and so weighted as to give to it a proper mass. The desired normal pressure could be obtained by sliding the point of suspension laterally so as slightly to incline the supporting rod, and further, by adding a weight so as to exert a proper leverage, if this was desired. The hammer electrode was pointed and carried by the diaphragm, which was of mica. The sounding pipe was gradually removed from or approached toward the microphone. Care was in all cases taken to keep the wind pressure constant. A single

\* Read at a meeting of the American Academy of Arts and Sciences, April 9th, 1890. From the *Technological Quarterly*.

Leclanché cell was ordinarily used, though in a few cases a Grénet cell was employed.

In the various tables, the excursions of the electrodes are in all cases given in fractions of an inch. In designating the material of the electrodes, that of the anvil is stated first.

Tables I. to III. show the results obtained when both electrodes were of carbon; Tables IV. and V., when the anvil electrode was of carbon, the hammer of platinum. Tables VI. to VIII. contain results of observations made with a modified form of transmitter, in which the anvil electrode was also somewhat heavier than in the earlier experiments.

TABLE I.

ELECTRODES, CARBON, CARBON.—*Magnification, 50 diameters.*

Excursion.	Character of Sound.
$1000 \times 10^{-6}$ to $700 \times 10^{-6}$	Constant breaking and sparks. Electrodes visibly separating.
$600 \times 10^{-6}$	Constant sparking. Electrodes occasionally seen to separate.
$200 \times 10^{-6}$	Occasional breaks and sparks.
$200 \times 10^{-6}$	Scratchy sound, no sparks.
No visible motion.	Sound clear and smooth.

TABLE II.

ELECTRODES, CARBON, CARBON.—*Magnification, 50 diameters.*

Excursion.	Character of Sound.
$1000 \times 10^{-6}$ to $600 \times 10^{-6}$	Constant sparks; electrodes separating.
$300 \times 10^{-6}$ to $200 \times 10^{-6}$	Harsh; occasional breaks and sparks.
$150 \times 10^{-6}$	Scratchy.
No visible motion.	Clear and smooth.

Whenever the excursion of the hammer was greater than  $100 \times 10^{-6}$  the sound was very scratchy and harsh.

TABLE III.

ELECTRODES, CARBON, CARBON.—*Magnification 160 diameters.*

Excursion.	Character of Sound.
$350 \times 10^{-6}$ to $300 \times 10^{-6}$	Loud, noisy, harsh.
$250 \times 10^{-6}$ to $200 \times 10^{-6}$	Very scratchy.
$120 \times 10^{-6}$ to $80 \times 10^{-6}$	Scratchy, but less than before.
$150 \times 10^{-6}$ to $100 \times 10^{-6}$	Scratchy, but with high overtones.

At the lowest amplitude given in Table III. the quality of the sound of the pipe was first heard, but a still less amplitude was necessary for its satisfactory reproduction.

TABLE IV.

ELECTRODES, CARBON, PLATINUM.—*Magnification, 160 diameters.*

Excursion.	Character of Sound.
$250 \times 10^{-6}$	Constant sparks and breaks.
$120 \times 10^{-6}$	Scratchy; occasional sparks and breaks.
$70 \times 10^{-6}$	Raspy.
$50 \times 10^{-6}$	Quality distinct, but high squealing overtones present.
$20 \times 10^{-6}$	Quality better; fewer high overtones.
Less than $20 \times 10^{-6}$	Quality better; some high overtones still audible.

The pipe had to be carried twice as far away from the transmitter as in last measurement, to a distance of 18 inches, before the quality became really excellent.

TABLE V.

ELECTRODES, CARBON, PLATINUM.—*Magnification, 150 diameters.*

Excursion.	Character of Sound.
$120 \times 10^{-6}$	Very scratchy; occasional sparks.
$60 \times 10^{-6}$	Squealing, high overtones.
$40 \times 10^{-6}$	Fair quality; high overtones prominent.
$< 20 \times 10^{-6}$	Good quality; a little rough.
$400 \times 10^{-6}$	Constant breaking.
$60 \times 10^{-6}$	Very raspy.
$40 \times 10^{-6}$	High overtones strong.
$20 \times 10^{-6}$	Quality good.

TABLE VI.

ELECTRODES, CARBON, PLATINUM.—*Magnification, 700 diameters.*

Excursion.	Character of Sound.
$200 \times 10^{-6}$	Rough, but pitch discernible.
$80 \times 10^{-6}$	Rough, pitch distinct.
$30 \times 10^{-6}$	Smooth, with high overtones.
$30 \times 10^{-6}$	"
$20 \times 10^{-6}$	Quality good; some high overtones.
$10 \times 10^{-6}$	Good quality.
$25 \times 10^{-6}$	Smooth, with high overtones.
$30 \times 10^{-6}$ to $40 \times 10^{-6}$	High overtones prominent.
$80 \times 10^{-6}$	Harsh and rough.

TABLE VII.

ELECTRODES, CARBON, PLATINUM.—*Magnification, 940 diameters.*

Excursion.	Character of Sound.
$1,000 \times 10^{-6}$ to $800 \times 10^{-6}$	Scratchy, with breaks.
$100 \times 10^{-6}$	Rough, with high overtones.
$80 \times 10^{-6}$	Wheezy, with high overtones.
$40 \times 10^{-6}$	Smooth, but with high overtones.
$30 \times 10^{-6}$	"
$60 \times 10^{-6}$	Rough, with high overtones.
$50 \times 10^{-6}$	Harsh, with high overtones.
$40 \times 10^{-6}$	Smoother.
$30 \times 10^{-6}$	Smoother, with high overtones.
$20 \times 10^{-6}$ to $30 \times 10^{-6}$	Good quality, high overtones present.
$20 \times 10^{-6}$	Good quality.

TABLE VIII.

ELECTRODES, CARBON, PLATINUM.—*Magnification, 940 diameters.*

Excursion.	Character of Sound.
$1,000 \times 10^{-6}$	Harsh and screamy.
$2,000 \times 10^{-6}$	"
$1,000 \times 10^{-6}$	High overtones heard; no distinct pitch transmitted.
$400 \times 10^{-6}$	High strident overtones present.
$100 \times 10^{-6}$	High overtones still present.
$60 \times 10^{-6}$	Sound wheezy.
$30 \times 10^{-6}$	Sound smooth.
$20 \times 10^{-6}$ to $10 \times 10^{-6}$	Quality good.

The differences in the effects obtained with a microphone in which both electrodes are of carbon, as compared with one in which one of the electrodes is of platinum, are well known to every one who has considered the subject. While with the latter it is more easy to produce an actual break of contact between the electrodes than with the former when the sound is increased, on the other hand the quality is much more satisfactorily reproduced, and does not so rapidly disappear on increasing the loudness. These differences were clearly noticed in the observations. Thus for slight excursions of the hammer electrode the quality of the sound with two carbon electrodes was found to be less satisfactory than when the hammer was of platinum, although in the latter case the point of actual breaking of circuit and sparking was usually reached with a less excursion than in the former one. Evidence of these differences appears in the tables just given, and also in those which follow.

It must be observed that while the figures given in the tables show what is the maximum amplitude of vibration of the electrodes consistent with the transmission of quality, they entirely fail to indicate the excessive minuteness of the least excursions which are capable of this result. How minute these sometimes are may be inferred from the following observation.

With a microphone having a somewhat heavy anvil electrode, the organ pipe was gradually moved away from the diaphragm, and the diminishing range of motion of the electrodes noted in the usual manner. When the pipe was at a distance of three inches the motion of the electrodes was too slight to be visible, although this could have been seen readily with the low magnifying power employed if it had been as great as  $\frac{1}{20000}$  in. The pipe, still blown with the same loudness, was then carried farther and farther away. At a distance of 36 feet, which was the most distant point from the microphone in the room, the sound of the pipe was still distinctly though faintly audible at the receiver placed in circuit with the microphone, and in a distant apartment.

The results shown in the preceding tables give an idea of the phenomena observable with a microphone of the structure employed. Inasmuch as the primary object of the measurements was to obtain some idea of the actual value of the excursion of the electrode, the mass and normal pressure of the electrodes were not particularly considered, except that they were so adjusted as to give good transmission with moderate loudness of the sound actuating the microphone. But it would of course be expected that the numerical value of the relative excursion of the electrodes corresponding to any given character of sound would vary with the mass of the anvil electrode and with the normal pressure between the electrodes. Two separate sets of observations were made to observe the effects of such variations by Messrs. Jones and Dame. The latter series was somewhat more complete than the former, besides being carried on with better instrumental appliances, and the results hereafter given are taken chiefly from it.

In all experiments of the nature of those under consideration, it is very difficult to get any fixed standard of quality to which to refer such results as the present. Different observers differ to a certain extent in their estimate of the excellence of the quality reproduced. But the point at which the distinctive quality of the transmitted sound disappears is quite well marked, and a very slightly increased vibration of the hammer electrode causes great harshness to result. For this reason, the name "critical point," originally suggested by Mr. Jones, has been given to this limit, and the excursion corresponding to it has been particularly noted, in tests of the varying effects of mass and pressure.

The transmitter used had its anvil electrode suspended like a pendulum, as before. In order to vary the mass without varying the normal pressure, a horizontal wire was suspended beneath the anvil electrode and rigidly attached to it. The middle point of the wire was vertically beneath the point of suspension of the electrode. The masses added consisted of small copper washers weighing 1.1 grams each. By adding two of these whenever the mass was to be increased, and placing one on each side of the middle point of the horizontal wire, the mass of the electrode was increased, while the normal pressure remained substantially constant. In the experiments whose results are contained in Tables IX. to XIII. the normal pressure was exceedingly small, the electrodes always being kept in very light contact. This condition of things was easily secured by a slight adjustment of the position of the washers. A magnification of 280 diameters was usually employed.

The following results were obtained by the mode of procedure just described.

TABLE IX.

ELECTRODES, CARBON, PLATINUM.

Mass in grams.	Excursion of hammer at critical point.
4.0	12 × 10 <sup>-6</sup>
8.1	25 × 10 <sup>-6</sup>
10.3	37 × 10 <sup>-6</sup>
12.5	50 × 10 <sup>-6</sup>
14.7	50 × 10 <sup>-6</sup>
17.0	50 × 10 <sup>-6</sup>
19.2	50 × 10 <sup>-6</sup>
21.4	50 × 10 <sup>-6</sup>

TABLE X.

ELECTRODES, CARBON, PLATINUM.

Mass in grams.	Excursion of hammer at critical point.
4.8	12 × 10 <sup>-6</sup>
5.9	25 × 10 <sup>-6</sup>
8.1	37 × 10 <sup>-6</sup>
10.3	37 × 10 <sup>-6</sup>
12.5	50 × 10 <sup>-6</sup>
14.7	50 × 10 <sup>-6</sup>
17.0	50 × 10 <sup>-6</sup>
19.2	50 × 10 <sup>-6</sup>
21.4	50 × 10 <sup>-6</sup>
25.8	50 × 10 <sup>-6</sup>

TABLE XI.

ELECTRODES, CARBON, CARBON.

Mass in grams.	Excursion of hammer at critical point.
8.5	18 × 10 <sup>-6</sup>
10.7	18 × 10 <sup>-6</sup>
12.9	25 × 10 <sup>-6</sup>
15.1	25 × 10 <sup>-6</sup>
17.3	25 × 10 <sup>-6</sup>
19.5	37 × 10 <sup>-6</sup>
21.7	37 × 10 <sup>-6</sup>
23.9	37 × 10 <sup>-6</sup>
28.3	37 × 10 <sup>-6</sup>

TABLE XII.

ELECTRODES, CARBON, CARBON.

Mass in grams.	Excursion of hammer at critical point.
5.7	12 × 10 <sup>-6</sup>
8.7	17 × 10 <sup>-6</sup>
10.9	25 × 10 <sup>-6</sup>
13.1	37 × 10 <sup>-6</sup>
15.3	37 × 10 <sup>-6</sup>
17.5	37 × 10 <sup>-6</sup>
19.7	37 × 10 <sup>-6</sup>
5.7	12 × 10 <sup>-6</sup>
9.1	18 × 10 <sup>-6</sup>
11.3	37 × 10 <sup>-6</sup>
15.5	37 × 10 <sup>-6</sup>
15.7	37 × 10 <sup>-6</sup>
17.9	37 × 10 <sup>-6</sup>
20.1	37 × 10 <sup>-6</sup>

TABLE XIII.

ELECTRODES, PLATINUM, PLATINUM.

Mass in grams.	Excursion of hammer at critical point.
7.65	12 × 10 <sup>-6</sup>
9.85	25 × 10 <sup>-6</sup>
12.05	31 × 10 <sup>-6</sup>
14.25	37 × 10 <sup>-6</sup>
16.45	37 × 10 <sup>-6</sup>
18.65	37 × 10 <sup>-6</sup>
20.85	37 × 10 <sup>-6</sup>
7.65	12 × 10 <sup>-6</sup>
9.85	25 × 10 <sup>-6</sup>
12.05	37 × 10 <sup>-6</sup>
14.25	37 × 10 <sup>-6</sup>
18.65	37 × 10 <sup>-6</sup>
20.85	37 × 10 <sup>-6</sup>

An inspection of Tables IX. to XIII. shows that the value of the excursion of the hammer electrode corresponding to the "critical point," and presumably, therefore, the excursion corresponding to any given degree of excellence in the reproduction of quality, at first rises very rapidly as the mass of the anvil electrode is increased, but soon reaches a maximum value, which is not altered by further increase of mass. The rise appears to be less rapid when both electrodes are of carbon, than when one or both of them are of platinum, as may be seen by a comparison of the various tables, or, better still, by plotting the results so as to exhibit them graphically by curves. Also, when both electrodes are of carbon or both of platinum, the maximum and permanent excursion at the critical point is considerably less than when the hammer electrode is of platinum and the anvil of carbon, a fact which goes to explain the well-known excellence of a microphone employing these last materials. Further experiment is desirable, however, before fully accepting this explanation. Furthermore, variations in the surface and shape of the electrodes are likely to modify these values to a certain extent. Thus the carbon electrodes used by Mr. Jones gave the results shown in Tables XIV. and XV. The arrangement of the electrodes was as already described, except that the anvil was slightly inclined, and in the second series a weight of bent wire was added to increase the normal pressure by a small amount.

TABLE XIV.

ELECTRODES, CARBON, CARBON.

Mass in Grams.	Excursion of Hammer at Critical Point.
6.5	36 × 10 <sup>-6</sup>
8.9	50 × 10 <sup>-6</sup>
11.3	60 × 10 <sup>-6</sup>
13.7	60 × 10 <sup>-6</sup>
16.1	60 × 10 <sup>-6</sup>
18.5	60 × 10 <sup>-6</sup>
20.9	60 × 10 <sup>-6</sup>
23.3	60 × 10 <sup>-6</sup>
25.7	60 × 10 <sup>-6</sup>

TABLE XV.

ELECTRODES, CARBON, CARBON.

Mass in Grams.	Excursion of Hammer at Critical Point.
2.9	29 × 10 <sup>-6</sup>
5.3	30 × 10 <sup>-6</sup>
7.7	40 × 10 <sup>-6</sup>
10.1	55 × 10 <sup>-6</sup>
12.5	60 × 10 <sup>-6</sup>
14.9	60 × 10 <sup>-6</sup>
17.3	60 × 10 <sup>-6</sup>

In connection with the various preceding tables the following results obtained by Mr. Jones will be of interest.

TABLE XVI.

ELECTRODES, CARBON, PLATINUM.

Series.	Magnification.	Excursion for Good Quality.	Excursion at Critical Point.	Excursion for Breaking.
1	400	16 × 10 <sup>-6</sup>	60 × 10 <sup>-6</sup>	80 × 10 <sup>-6</sup>
2	400	20 × 10 <sup>-6</sup>	30-40 × 10 <sup>-6</sup>	60 × 10 <sup>-6</sup>
3	400	30 × 10 <sup>-6</sup>	50 × 10 <sup>-6</sup>	80 × 10 <sup>-6</sup>
4	350	30 × 10 <sup>-6</sup>	60 × 10 <sup>-6</sup>	80 × 10 <sup>-6</sup>
5	700	40 × 10 <sup>-6</sup>	60 × 10 <sup>-6</sup>	80 × 10 <sup>-6</sup>
6	1000	30 × 10 <sup>-6</sup>	70 × 10 <sup>-6</sup>	80 × 10 <sup>-6</sup>

In Series 2 the normal pressure was slightly less than in the others. The excessively high value of 40 × 10<sup>-6</sup>

at which in Series 5 good quality still persisted, is the highest that has been observed. The hammer electrode had been brought to a sharp point just previously.

I have observed, among the four persons who have employed the method under consideration, that each one has apparently his own standard of what constitutes good quality, and usually adheres quite closely to this in different experiments. The observer last cited generally gave somewhat larger values to the excursion for a given degree of excellence of transmission than I noted in my own observations, apparently from this cause.

A further series of measurements was made in order to ascertain what effect was produced by a variation in the normal pressure between the electrodes.

In order to do this, a wire was caused to project backward from the anvil electrode, and small weights were hung upon the end of it. The pendulum electrode with this projecting wire constituted a bent lever whose arms were easily measured, thus enabling the normal pressure due to a given weight to be calculated. It was thus obtained very easily, although the method is subject to the objection that there is a certain variation of the mass of the anvil electrode simultaneously with the variation in pressure. The use of a delicate spring instead of the weight would be preferable, but I have not yet found time to carry through observations by this method. The results reached are shown in Tables XVII. to XIX.

TABLE XVII.

ELECTRODES, PLATINUM, PLATINUM.	
Normal Pressure in Grams.	Excursion of Hammer at Critical Point.
0.34	$8 \times 10^{-6}$
0.77	$14 \times 10^{-6}$
1.20	$25 \times 10^{-6}$
1.63	$37 \times 10^{-6}$
2.06	$50 \times 10^{-6}$
2.50	$61 \times 10^{-6}$
0.34	$10 \times 10^{-6}$
0.77	$12 \times 10^{-6}$
1.20	$25 \times 10^{-6}$
1.63	$37 \times 10^{-6}$
2.06	$50 \times 10^{-6}$
2.50	$61 \times 10^{-6}$
2.93	$61 \times 10^{-6}$

TABLE XVIII.

ELECTRODES, CARBON, CARBON.	
Normal Pressure in Grams.	Excursion of Hammer at Critical Point.
0.297	$8 \times 10^{-6}$
0.632	$12 \times 10^{-6}$
0.990	$12 \times 10^{-6}$
1.288	$12 \times 10^{-6}$
1.650	$25 \times 10^{-6}$
2.150	$25 \times 10^{-6}$
0.272	$8 \times 10^{-6}$
0.616	$25 \times 10^{-6}$
0.960	$37 \times 10^{-6}$
1.304	$37 \times 10^{-6}$
1.648	$37 \times 10^{-6}$
1.990	$37 \times 10^{-6}$

TABLE XIX.

ELECTRODES, CARBON, PLATINUM.			
Normal Pressure in Grams.	Excursion of Hammer at Critical Point.	Normal Pressure in Grams.	Excursion of Hammer at Critical Point.
0.184	$8 \times 10^{-6}$	0.184	$8 \times 10^{-6}$
0.288	$12 \times 10^{-6}$	0.288	$12 \times 10^{-6}$
0.432	$12 \times 10^{-6}$	0.632	$12 \times 10^{-6}$
0.632	$12 \times 10^{-6}$	0.990	$12 \times 10^{-6}$
0.990	$12 \times 10^{-6}$		
1.288	$12 \times 10^{-6}$	0.180	$8 \times 10^{-6}$
1.654	Anvil vibrating.	0.395	$12 \times 10^{-6}$
		0.620	$12 \times 10^{-6}$
0.104	$>8 \times 10^{-6}$	0.644	$12 \times 10^{-6}$
0.132	$>8 \times 10^{-6}$	0.149	$8 \times 10^{-6}$
0.153	$8 \times 10^{-6}$		

It appears from these results, that the value of the excursion corresponding to the critical point rises with increase of normal pressure, soon attaining a maximum and constant value. The pressure at which this maximum value was reached was greatest when both electrodes were of platinum, and least when the hammer electrode was of platinum and the anvil of carbon. When both electrodes were of carbon, the value lay between these two extremes. The unexpected result was also reached that the value of the maximum excursion was much greater when both electrodes were of platinum than when both were of carbon. It was least when the hammer was of platinum and the anvil of carbon.

A series of observations was also made upon the microphone of the Blake transmitter. These presented considerable difficulty on account of the construction of the parts of that instrument, and only a low magnifi-

cation could be used. Three sets of measurements were taken, the first with a very light normal pressure, the second with the ordinary pressure, and the third with a very heavy pressure. With this microphone in its proper condition, both electrodes moved. It was therefore necessary to subtract the excursion of the anvil electrode from that of the hammer, in order to obtain their relative motion. The results reached are given in Table XX. The total excursion of the hammer electrode, and its motion relative to the anvil, are given as nearly as they could be measured.

TABLE XX.

BLAKE TRANSMITTER.—ELECTRODES, CARBON, PLATINUM.

A. Light Normal Pressure.		
Total Excursion.	Relative Excursion.	Character of Sound.
	$<25 \times 10^{-6}$	Good quality, very faint.
$50 \times 10^{-6}$	$25 \times 10^{-6}$	" " clear.
$100 \times 10^{-6}$	$50 \times 10^{-6}$	Overtones strong.
B. Medium Normal Pressure.		
	$<25 \times 10^{-6}$	Good quality, very faint.
$75 \times 10^{-6}$	$25 \times 10^{-6}$	" " clear.
$100 \times 10^{-6}$	$50 \times 10^{-6}$	Overtones strong.
C. Heavy Normal Pressure.		
	$<25 \times 10^{-6}$	Good quality, very faint.
$100 \times 10^{-6}$	$25 \times 10^{-6}$	" " clear.
$150 \times 10^{-6}$	$50 \times 10^{-6}$	Overtones strong.

These results, although of only approximate exactness, are interesting, as they show one cause of the excellence of the Blake transmitter in practice, in that the mode of support of the electrodes allows of very considerable variations in the absolute motions of both of them without material change in their relative motions.

Rogers Laboratory of Physics,  
March, 1890.

ELECTRIC LIGHT FATALITIES.

ON September 30th last an inquest was held to enquire into the cause of the death of August Kopp, who was killed while at work on an electric light pole at the corner of Thirty-fifth Street and Broadway, in New York, on the night of the fifteenth of the month, and whose untimely end has already been noticed in our columns. The coroner's jury, composed principally of electrical men, brought in a verdict to the effect that Kopp would not have lost his life had he exercised proper care (*i.e.*, had he been wearing at the time the rubber gloves provided by the company), and further, that "while said August Kopp did not exercise proper care, it has appeared in evidence that the defective insulation which existed at the various arc lamps was a necessary factor in causing his death; and that the existence of such defective insulation was countenanced by the Board of Electrical Control. It is the opinion of this jury that the operation of high-tension electric circuits in such condition is a dangerous practice."

For a proper understanding of this verdict, says the New York *India-rubber World*, it is necessary to review the evidence given at the inquest, by which the exact manner in which Kopp met his death and the various contributing causes were made clear. It appears that Kopp, who was a patrolman in the employ of the United States Illuminating Company, was inspecting the working of the lamps in a certain district on the night in question, and observing that the lamp at Thirty-fifth Street and Broadway was extinguished, he climbed the pole to remove the cause of trouble, although he had left his rubber gloves at the Central station. Kopp, therefore, did not "exercise proper care," and directly violated the rules of the company which provide that all employes shall wear rubber gloves when working on live circuits. It is a matter of history that he paid the penalty of his excess of zeal with his life, but exactly how this came about has not

been correctly stated in any published report of the accident.

It appears from the evidence that the circuit was grounded on the lamp frame through a defective insulator and Kopp's idea was to remove the ground from the circuit by cutting out the lamp. He effected this by baring a small portion of the insulated wires by which the lamp was connected to the cables and joining them across by means of a "jumper"—a short, thick piece of wire heavily insulated and provided with a clamp at either end for making the connections. Having thus cut out the lamp, he proceeded to disconnect the wires from the lamp terminals, and endeavoured to twist them together in order that he might remove the jumper. In making the attempt, he touched one of the bare ends and thereby received the shock that resulted in his death.

It would appear to most persons that, having fixed the "jumper" properly and so completed the circuit, Kopp ought to have been able to handle the free ends without receiving any hurt, as they then only represented one side of the circuit. His death having been produced in this way shows that the circuit must have been grounded at some other point, or at least that the total insulation of the circuit was so low that it practically amounted to a ground; Kopp, clinging to the iron pole and lamp support, made a second ground, and he naturally received a powerful shock.

The circuit consisted of about  $4\frac{1}{2}$  miles of underground cable,  $1\frac{1}{2}$  miles of overhead wire and 48 arc lamps, and according to the evidence of the self-satisfied gentleman who poses as expert to the Board of Electrical Control, the insulation of the entire circuit, measured in *fine weather*, was about 1.6 megohms. This result was obtained some days before the accident and some days after, but no test was made on the day of the accident or on the day following. Wet weather prevailed about that time, and it had never occurred either to the expert or to the superintendent of the company to have a test made in wet weather, and the latter official could only guess at the probable insulation of the circuit under such conditions, placing it at about half a megohm. This was a very liberal estimate, about a fiftieth part of that figure would probably be nearer the mark. The point is that the company did not know and the "expert" to the Board did not know how low the insulation fell, or, in other words, whether the circuit was safe or dangerous in wet weather, and apparently they did not care to know; they could only say that under the best conditions the insulation of the circuit was fairly good. The experience of lineman Kopp showed that in wet weather to touch one side only of the circuit meant death, and the company owe it to their good luck that the man had infringed their rules in not carrying his rubber gloves, as even though he had had them the wire might have touched some other part of his body, say his neck or face, in which case he would have been killed just the same.

The evidence given on behalf of the company shed some light on a lamentable method, or rather want of method, in testing circuits and keeping records of tests made. It is with some surprise that we learn of an important company, like the one in question clinging to the antiquated magneto bell test—a test which means nothing at all, as the witness for the company could not even say what resistance the bell would ring through, the deduction being that it would only show whether the circuit was dead grounded or not. The insulation might fall dangerously low, but the magneto would give no sign.

The main point to be borne in mind in connection with this peculiar case is that Kopp was killed because the insulation of the circuit was so low as practically to amount to a "ground." The witness for the company accounted for this low insulation by crediting it to the accumulation of leakage from the arc lamps, the frames of which form part of the circuit. This explanation probably accounts for a great deal of the leakage, and the rest would no doubt be made up among the overhead wires, and poorly insulated connections between lamps and cables.

The fact remains, however, that the insulation of such a circuit falls dangerously low in wet weather, and we fully concur in the verdict of the jury characterising the operation of high-tension circuits in such condition as a dangerous practice. It remains for the electric light companies to find the remedy, and it would clearly seem to be the duty of the Board of Electrical Control to insist upon some remedy being applied. If the present construction of arc lamps is such that they afford escapes for the current in wet weather, it ought to be no very difficult matter to improve the construction so as to eliminate this dangerous defect. A vast amount of work has been done in the production of efficient arc lamps, surely our industrious inventors might now turn their attention to the design of one that shall be safe.

We sympathise with the electric light companies to a certain extent for the persecution they underwent last winter, but at the same time we have an idea that they are rather inclined to carry things with a high hand where they have the chance; now that it has been clearly shown that the first element to be considered in the operation of high-tension currents, namely, insulation, is disregarded to the extent of rendering the operation of their circuits a "dangerous practice," we think that the sooner they are compelled to adopt improvements in their methods of construction the better it will be for all parties concerned.

## PRACTICAL PROBLEMS.

OUR readers, says the editor of *L'Electricien*, often ask questions of general interest demanding a reply that would exceed the limits of space that we can devote to them in the correspondence column. We will in future answer them under the heading "Practical Problems," which we now introduce. We shall number these problems, as we number the items of useful information, in order to facilitate reference.

I. Provisional employment of accumulators in a lighting of 110 volts.

A consumer supplied normally by a machine with a constant potential of 110 volts wishes to keep four or five lamps lighted for some hours in the daytime, or when the machine is stopped for repairs or cleaning.

It is evident, in this particular case, that he must have recourse to accumulators; but the solution that suggests itself, *à priori*, and which consists of establishing a series of 55 accumulators in derivation on the dynamo, is far from being either the most economical or the most simple method.

In short, these 55 accumulators entail at the outset an expenditure which cannot be less than 800 francs, as the smallest industrial type of accumulator costs at least 15 francs.

We should prefer to substitute for the four or five lamps that are to work while the motor is stopped, double the number of lamps working at 25 or 30 volts, for instance, requiring only from 13 to 15 accumulators for their maintenance. The four or five lamps working at 75 or 80 volts are connected in derivation from one to another, but in series with the battery of accumulators, and in derivation on the terminals of the dynamo, which then charges the battery at the same time as it supplies the lamps connected in series with the accumulators.

At the moment of stoppage, a simple commutator cuts off the communication between the accumulators and the machine and the lamps of 75 volts, and places the lamps of 30 volts in derivation on the accumulators. We thus realise a considerable saving on the cost of the accumulators, and we are sure of charging them with a current that is very constant, which is favourable to their preservation. The doubling of the lamps may be avoided by installing lamps of 50 volts which, during the charge, would be connected in series with the accumulators, and in derivation on the terminals of the dynamo. During the discharge, the accumulators and

the lamps would be separated from the dynamo, and the accumulators would supply the same lamps of 50 volts. By this second method, 27 or 28 accumulators would be required instead of 55; but the first plan is the more advantageous, for, taking into consideration the high price of the accumulators and their depreciation, it is still more economical to double the number of lamps than to double the number of accumulators.

If the attendant should happen to forget to use the commutator at the moment when the dynamo stopped, the accumulators would only be discharged very slowly over the resistance represented by the lamps of 75 volts introduced into the circuit charged. It is, moreover, easy to arrange that an automatic disconnecter should effect the commutation at the moment of the stoppage of the dynamo, for the current supplied by the accumulators being of an opposite sign to that supplied by the dynamo during the charge, it must pass through zero in order to change its sign, and thus the disconnecter cannot fail to act at the moment required.

We will suppose that lamps of 50 watts (16 candles) are required, each requiring 25 volts and about 2 ampères. The output will be 15 ampères. We shall only require to use 13 accumulators at 25 francs each, or 325 francs worth of accumulators instead of 800, in order to supply this special service. These accumulators, containing 100 available ampère hours, will ensure the working of the five lamps for 10 hours, which is more than sufficient in this particular case.

The method we have described of lessening the number of accumulators required in an installation with a potential of 110 volts may be applied in all cases in which these accumulators are only required to supply a limited number of lamps, late at night, for instance.

### SOME OF THE ENGINEERING PROBLEMS CONNECTED WITH THE RE-ESTABLISH- MENT OF THE WESTERN UNION TELE- GRAPH COMPANY, AFTER ITS RECENT FIRE IN NEW YORK CITY.\*

[By A. C. ROBBINS.

ON the morning of the 18th of July last, occurred the most disastrous fire in the history of the electric telegraph. The General Operating Department of the Western Union Telegraph Company, at New York, was completely destroyed. The general operating room occupied the entire seventh floor of the Western Union building, with a frontage on Broadway of 75 feet, and on Dey Street of 150 feet, and furnishes employment to upwards of one thousand people, operators, clerks and messengers. The height of the room was about 21 feet. A gallery extended across the Broadway end of the room, and was occupied by the Commercial News Bureau.

The room contained a main line switch having a capacity of about 700 wires; a city line switch with about 250 wires; a loop switch of 200 loops; 40 sets of quadruplex instruments; 40 sets of duplex instruments; about 700 simplex instruments; the pneumatic tube system; 3 sets of the Hughes-Phelps printing telegraph apparatus; a rapid transit distributing system; and offices of the management and staff.

The battery room was located on the sixth floor, and contained about 20,000 cells, principally of the zinc-copper, gravity form. The coat and toilet rooms were also on this floor.

The eighth floor was occupied by the Associated Press operating department, and the Western Union book-keeping department and the *employés'* lunch room.

The ninth floor contained the kitchen and lodging rooms of the lunch room *employés*. The tenth floor was used as store rooms for records, and other miscellaneous matter.

The wires entered the building at the cellar, and were 2,000 in number, conveyed to the operating room in cables containing from 50 to 100 wires each, through flues in the central partition wall of the building.

How the fire originated is something of a mystery, and probably will ever remain so. It was discovered by various people on the sixth and seventh floors simultaneously at about 7 o'clock, and spread with such rapidity that several who tarried a few moments in vain endeavour to extinguish it, found the stairways a seething mass of flame, and their only means of escape to be through the windows, from which they were in various ways rescued by gallant firemen, happily without loss of life or accident; as was the case with some half dozen *employés* who were rescued from the roof by the life-saving corps of the fire department.

While the engines were yet playing upon the building, operators were detailed to Jersey City, Brooklyn, Weehawken, Hoboken, Harlem, and all possible available suburban offices in all directions, there to tap the wires, and handle the vast business as best they could.

Almost before the fire was entirely extinguished a part of the engineering staff repaired to the former operating room of the defunct Baltimore and Ohio Telegraph Company, on the fifth floor of No. 415, Broadway, where, with only a room destitute of all furniture, an electric light dynamo in the cellar, and a permit from the authorities to string a few temporary aerial wires, they proceeded to open up communication with the outside world.

Cables were strung to, and connected with, the trunk line cables on the Sixth Avenue Elevated Railway structure, the dynamo in the cellar was put in operation, and at seven o'clock in the evening, after seven hours' labour, they were working their first wires. By Saturday morning they were working 20 wires; and on Saturday evening electric lights, furnished with current from the dynamo in the cellar, replaced the candles and lanterns of the previous night. On Sunday morning a second dynamo for furnishing current of opposite polarity to that of the first one was in operation, and 12 duplex systems were started. Monday morning found this energetic party operating 15 duplex and 25 simplex circuits to the north, east and south.

The fire occurred on the regular weekly pay-day of the *employés*, and the systematic and business-like methods of this company is finely illustrated in the fact that every *employé* who presented his voucher to the cashier on that day received his salary. One *employé* humorously remarked that while the engines were pouring water into one window he received his money from out another.

The scene inside the building, after the fire, beggars description. It was enough to discourage the stoutest heart. Everything burnable above the fifth floor was entirely consumed. In the operating room, the largest piece of combustible material left was the leg of a table.

The once magnificent switchboard was reduced to a mass of melted brass, and twisted beams, and to trace the identity of a single wire from out the tangled mass would be as difficult as tracing a thread in the broken web of a spider.

Water flowed from the building in rivers, and for days afterward dripped from the ceilings of every floor. This dripping was the source of great annoyance in the work of reconstruction, and in many instances, during the first few days, instruments and wires had to be covered with tarpaulin to protect them from the water.

On the morning succeeding the fire new life was inaugurated amidst the ruins. The fifth and a part of the fourth floors were to be converted temporarily to the uses of the operating department.

The occupants of these rooms were busy removing to other quarters; an army of workmen were engaged in erecting switches, building tables, setting up instruments, and running wires.

\* Paper read before the Electrical Department of the Brooklyn Institute, October 10th, 1890.

The conduit from the cellar was opened in the hall on the fourth floor, and the work of testing out and identifying each one of the 2,000 wires therein was commenced. The pneumatic tubes were opened up in, and business with their terminals conducted from, the cellar.

Day and night the work progressed, until, one by one, as fast as wires were provided, the entire force was brought back. On the following Saturday, eight days after the fire, nearly all of the wrecked wires had been re-connected in working order at the general operating department, and the temporary quarters at 415, Broadway, were abandoned.

Gradually the business resumed its former and well organised routine, until to-day, as for several weeks past, with rude pine benches for desks, and wires strung promiscuously around the ceilings, an unusual delay to a *single* message, and the cause therefor, is instantly known to the management.

One of the worst difficulties encountered in this re-establishment was a lack of proper apparatus, and at times the engineering staff were severely taxed in substituting for apparatus not in stock, and which was needed immediately; for instance, the dynamo duplex and quadruplex systems require pole reversing transmitters different from the ordinary, in that they require only two points of contact in place of four, where a battery is used.

The dynamo quadruplex system also requires resistances of 600, 900 and 1,200 ohms respectively, in proportioning its currents, and it also requires a set of battery and ground switches of peculiar construction.

Of this apparatus, and much more, only samples are kept in stock, and considerable time is necessary to construct when required. In substituting for the pole reversing transmitters, the battery style (of which, fortunately, there was a good supply) was used by the insertion of ivory insulation on two of its contact points. For the quadruplex proportional resistances, incandescent lamps were used until the proper resistance coils could be obtained. While the lamps, as a makeshift, answered fairly well, I cannot say that I consider them a decided success, as they are too sensitive to changes of temperature. The proper equilibrium of the apparatus at the distant station, to a very considerable extent, depends upon the joint resistance of the 900 and 1,200 ohm resistances; equalising that of the independent 600 ohm resistance; and, again, the outgoing current is regulated in proportion as is the 900 to the 1,200 ohm resistance, so that a quadruplex circuit working nicely for a part of the day, is liable to become unsteady, or variable later on by a change in the wind, or draughts of air from an open window, which may cause one set of resistance to vary considerably more than the others. Constant watching, however, partly overcame this difficulty. For 9 point combination dynamo and ground switches, 3 point switches were connected in substitution.

Another difficulty experienced was the want of battery room. No room was available for this purpose, except some shelves in the halls, and boxes under the desks. This was overcome by using the Edison-Lalande caustic soda battery, which, while of low pressure, furnishes quantity sufficient for from 8 to 10 circuits from one battery.

There are 5 local circuits on each set of quadruplex instruments; these circuits ordinarily require 10 cells of gravity battery; 4 cells of the caustic soda battery has been found ample to work the local circuits of two sets of quadruplex, a saving of 16 cells, or 80 per cent. in battery room. The same percentage was secured in saving of battery room for the local batteries of the multiplex city loops, several loops being supplied from one battery.

The 20,000 cells of battery used previous to the fire have been replaced by 1,750 cells; and, in a few weeks, perhaps days, not a single cell of chemical battery will be used for telegraph purposes in the general operating department.

For several years past the dynamo has provided current for the main circuits from New York. A poten-

tial of 70 volts, regulated by a system of joint resistance, multiple supply, has been applied for supplying the loop locals. For intermediate batteries special apparatus is required for each battery. A one-eighth horsepower motor is by current from the building incandescent lamp circuit, run at a speed of about 2,200 revolutions per minute. This motor in its turn operates a generator of equal size and at about the same rate of speed, from which is obtained a current potential of about 100 volts—sufficient for all intermediate battery purposes. The saving in room is 40 square feet for each intermediate battery. About 50 intermediate batteries were formerly used, but the number will probably be reduced somewhat.

Another question of space was presented when incandescent lamp room was considered. Each battery lead before reaching its wires has a resistance inserted in form of from one to four incandescent lamps for the prevention of damage in cases of accidental short-circuiting. 5,000 of these lamps are necessary for use on the main line switches, and as each lamp requires a space of 3 square inches, or a total of 104 square feet, the problem was an important one.

This was happily solved by placing the lamps on a framework over the switch. In so doing two results are obtained, viz.: Space otherwise useless is utilised; and, secondly, yet of still greater importance, the wire chief is enabled, by watching his lamps to note grounds and crosses on his wires, and by prompt action from such observation prevent destruction by overheating of the instruments in circuit. For the multiplex currents, spaces on the framework of the doors and windows have been utilised, and the lamps thereon serve as monitors for those in charge of the apparatus.

Previous to this arrangement, the burning out of magnets by accidents to heavily charged circuits was a frequent occurrence. Since this improvement, I have yet to hear of the destruction of a single coil in this manner.

The building stood the heat wonderfully well; heat which caused the granite trimmings of the doors and windows to flake and crumble, and glass to melt, had no effect whatever upon the massive walls.

The operating room which, when first occupied some 17 years ago, was generally supposed to be adequate to the requirements of the department for all time to come, has for years been entirely too small for the rapidly increasing business.

Particularly during the past five years have these quarters become crowded, and the stern necessity of utilising every inch of available space been forced upon the management.

Just previous to the fire a prominent official of the department remarked that he did not see how they could work through the coming busy summer season without more room, and that to do so a year hence would certainly be an impossibility. This is only one of many indications of the rapid growth of the telegraph business in recent years. With this experience, it has been decided to rebuild the structure from the fifth floor up, and to extend the building 25 feet on Dey Street; and it is confidently predicted that when completed it will be the finest and most complete telegraph office in the world.

The remodelled building will be nine storeys high, and the old mansard will be replaced by a flat roof. The sixth floor will be used for offices for various departments; the seventh and eighth floors for operating rooms, and the ninth floor will be occupied by wardrobe and lunch rooms, kitchen, &c.

The operating rooms on the seventh and eighth floors will each have a frontage on Broadway of 75 feet, and on Dey Street of 175 feet—considerably more than double the space occupied before the fire, and will be furnished with every facility that can be procured to secure perfection of operation. There will be used twelve dynamos in series of four each for the main line batteries, two only being in use at any one time, and the third series being kept in reserve in case of accident to either of the others. Two dynamos of low voltage will furnish the current for instrument local

circuits, one being used and the other held in reserve. Two dynamos will be devoted to supplying current for city multiplex loop, local circuits, one of them as a reserve; and as many sets of the one-eighth horse-power motors and generators will be used as there may be intermediate batteries required. The chemical battery will have no place in this model telegraph equipment, its day of usefulness having passed.

To the telegraph engineer it is a pleasing one. It marks an advance of the telegraph, in keeping with the progress of electrical science up to the present time, and we can feel assured that the results will be such as to induce the management to apply the improvements to all the principal offices of the company in the near future.

There is great need of improvements in insulating material. An insulation for wires is needed that will be cheap, light, flexible, and durable; one that dampness will not decay, nor the heat of an electric arc dissolve or burn. A fire extinguishing liquid is also to be desired which will be a non-conductor of electricity. When these have been obtained, and not until then, can the large telegraph offices be absolutely assured of protection from fire.

Please consider this matter. The one who succeeds in obtaining these results will, I am sure, be richly rewarded for his trouble. Nearly all the *employés* lost personal property in the fire, of greater or less value. Some of the losses were memoranda of experiments never to be repeated, or the gift of some departed friend, and can never be replaced. To some of the *employés* their losses were, to them, a much more serious matter than was to the company its more formidable calamity; yet from these *employés* are heard no complaints or lamentations; and, with sad regrets for their misfortune, all turned with eager hands to lend their aid to the restoration of public service.

This disaster has demonstrated that there is to-day between the Western Union Telegraph Company, and its *employés* in New York City, a combination of capital, labour, and harmony. Capital for dividend on its investment; labour for the love of science, and advancement of its chosen profession, and both harmonising in successful endeavour to make the now largest telegraph office the most perfect one in the world.

### A SUGGESTION.

(COMMUNICATED.)

AT present there are many English electrical firms who would be disposed to undertake an export trade, whilst others who have already established foreign connections are desirous of extending their sphere of operations in other countries. The difficulties to be overcome, however, in order to attain these objects are so great that some firms have given up the idea of opening up or cultivating an export trade. The first question which arises in the mind is, how are foreign business transactions to be effected? There appear to be only two methods which can be adopted. The first is the formation of a branch house. It would, of course, necessitate the expenditure of too much money to establish branch offices in different countries, although two or three electrical firms have already taken this step by founding branch offices abroad. Still, to the majority this would be impossible, and the idea may therefore be left out of consideration. The alternative is the appointment of *bonâ fide* representatives capable of efficiently carrying out work according to instructions. But the difficulty to be surmounted is to ascertain the good faith of foreign importers or representatives.

The two electrical directories are excellent as far as they treat the electrical industries, but they do not give all the information which an exporter would desire to know, and the choice of an agent from either might lead to pecuniary loss. What is, therefore, required is

an electrical trades handbook for the export trade. It should give in numerical order the names and addresses of only financially sound English and foreign export firms, together with a list of the specialities sent and received abroad, of the goods made by English export firms, details of electrical apparatus imported into foreign countries, their coinage, weights and measures, customs' tariffs, cost and means of transport, the names of responsible agents, lawyers, banks, importers at the principal ports, practical hints as to the means of trading, and last, but not least, a "black list" of those firms with whom it is undesirable to transact business without pre-payment *in cash*. A book of this kind would show to the exporter what to arrange and what to avoid. This want has just been filled in Germany for almost all trades, by Messrs. W. J. Schmidt and Gelbrecht, of Berlin, N., who have published a volume entitled, *Export-Hand-Adressbuch von Deutschland*. The list of export firms alone numbers over 4,200, the electrical industry being but briefly referred to. The black list is remarkable, and one of the many peculiar cases is worth mentioning. A Vienna boot manufacturing firm sent to an agent in London a case of boots as samples, but they were not returned, notwithstanding the fact that all of them were for the *right foot*!

### THE FLORENCE ELECTRIC TRAMWAY.

SINCE the Note appeared in our last issue regarding the electric tramcar accident in Florence, a copy of our Italian contemporary, *L'Elettricità*, containing a description of the tramway, has come to hand. The Sprague system, as worked in the Italian town, does appear to be, as the correspondent of the *Standard* pointed out, "a complicated arrangement of overhead wires."

The generating station is situated at S. Gervasio, in Fiesolo, and contains three large tubular boilers made by Tosi Brothers, of Legnano. These boilers supply steam to three compound engines furnished by the Oerlikon Engineering Works. Each engine runs at 245 revolutions and is of 100 H.P. The engines drive three Sprague dynamos at 900 revolutions, the capacity of each being 55,000 watts. All the electrical plant has been despatched from the Schenectady works of the Sprague Motor and Railway Company. The tramway is 5 kilometres in length, and in addition to the many curves, the difference in level between the Piazza S. Marco in Florence, and the Piazza del Duomo in Fiesolo, is about 270 yards. One pole of each dynamo is connected with an insulated main copper cable which is carried at the side of the tramway, whilst the other pole is jointed to a second or binary wire, which forms the return. The main cable is attached by means of insulators to vertical standards arranged laterally along the route at intervals of from 32 to 43 yards. From this cable branches are taken off to a secondary conductor termed the service wire, which consists of silicon bronze 5 mm. in diameter. The latter is placed slightly above the return wire, and is partly supported by brackets projecting from the standards and partly by means of wires arranged transversely. The standards erected inside Florence consist of light iron posts placed at the side of the footpaths, whilst outside the town they are wooden masts, all being about 20 feet high. The current is collected from the service wire by means of a trolley supported by an arm from the roof of the car, and passes down to the motors. Each car has arranged under its body two Sprague motors of 15 H.P. each, each motor driving independently one of the axles by means of gearing. A switch for increasing or diminishing the speed is placed at each end of the car. The number of cars in service is 12, each having a seating capacity for 24 passengers. The cars are lighted inside by five incandescent lamps, whilst externally there are two lamps which serve as head lights.

# RECENT RESEARCHES ON THE ELECTRICAL CONDUCTIVITY OF CERTAIN LIQUIDS.

CONDUCTORS of electricity may be regarded from two points of view. They may be considered as endowed with a greater or less facility for allowing electricity to pass through them, and, again, they may be considered, when placed in a circuit, as offering a greater or less resistance to the passage of an electric current. Each of these methods of regarding conductors is, in algebraical language, the *inverse* of the other.

We need not here enter into the relative merits and demerits of the various plans which are generally used for measuring conductivity and resistance. They are familiar to every student of electricity. But in the investigation of these properties, in so far as they are exhibited by certain particular substances, it is often necessary to modify the details, if not the principle, of any experimental method which may be resorted to, and these will be alluded to in due course.

To the early observers, the metals presented themselves as the most obvious conductors of electricity, and it was some time before it was definitely recognised that many other substances, supposed to be indifferent in their action, possessed the property of conductivity, although in varying degrees. Matthiessen's work on the conductivity of metals at zero Centigrade is still regarded as standard, but other physicists have obtained very conflicting results. This has mainly arisen from the character of the specimens examined; they have rarely been uniformly pure, and have often possessed a different molecular character.

The influence of temperature upon the conductivity of substances is affected by the physical condition of those substances. In the case of the metals, it has been shown that their electrical conductivity is diminished when their temperature is raised. And the law of this diminution is expressed by the formula

$$K_t = K_0 (1 + a t + b t^2),$$

when  $a$  and  $b$  are constants, which are probably the same, for all pure metals, and  $K_0$  and  $K_t$  the electrical conductivities of the metals at temperature  $0^\circ$  and  $t^\circ$  Centigrade.

Liquids and fused conductors in general are opposite in their behaviour under the influence of temperature, thus their electrical conductivity is increased by a rise of temperature. And the laws of this increase is expressed by the formula

$$K_t = K_0 (1 + a t),$$

when, as before,  $a$  is a constant,  $K_t$  and  $K_0$  are the electrical conductivities at temperature  $0^\circ$  and  $t^\circ$  Centigrade.

Now the chemical decompositions which are effected by a voltaic battery have been explained by the well-known theory of Grothüss. Assuming that in every binary compound or substance which may be considered to act as such, one of the elements is electro-positive, whilst the other is electro-negative. Grothüss predicates that under the influence of the contrary electricities of these electrodes, a series of successive decompositions and recompositions from one pole to the other is effected in the liquid in which they are immersed. Hence the elements which appear free at the electrodes and do not recombine are those which are, so to speak, the terminal molecules.

This theory of Grothüss's can be applied to the acids, the salts, and to the metallic oxides.

But there were various objections lodged against this theory, and in overcoming the chief of these Clausius applied the theory which is now universally admitted by the leading physicists, and which explains the constitution of liquids. In a liquid there is vibratory, rotatory and progressive motion; the molecules have no fixed positions; they are in a perpetual state of separation and reunion. The hypothesis assumes that compound bodies and their elementary constituents coexist with each other in a liquid. Hence, when a current of

electricity passes through them it influences the motion of the molecules in such a way that certain of them pass to the positive electrode whilst others pass to the negative electrode, and their recombination is prevented. The current does not bring about the decomposition, but it *utilises* it to give definite direction to the particles which are already separated.

Now these interesting considerations explain why the electrical conductivity of a liquid increases with the temperature, for heat, as every student of thermodynamics knows, increases the velocity of the molecules; not in a direct ratio to the rise of temperature, because the number of collisions of molecules per unit of time is also increased, but a little more slowly than in direct ratio. It also follows that electrical conductivity increases with the concentration of the liquid.

Within the past few months a great deal of attention has been directed to the estimation of the electrical conductivity of fused salts and solution of salts.

Foussereau stated some time ago that in the case of fused salts there is a sudden change of conductivity at the melting point (vide *Comptes Rendus*, vol. xcvi., p. 1,325). This was accepted with some hesitation at the time. L. Graetz, a German physicist, has recently been investigating the truth of the assertion experimentally. He made use of the following method:—

A quantity of the salt which is to be examined is placed in a small porcelain crucible. The lid of this crucible is perforated with four holes, two of which serve for the introduction of the wires which lead to the electrodes, and the other two for those of the thermo element, which is used for measuring the temperature.

The crucible is placed in a large sand bath, and precautions are taken in order that the conducting wires may be kept hot, so as to prevent solidification of the fused salt on the electrodes and on the junction.

The sand bath is heated to considerably above the melting point of the salt, and then allowed to cool slowly, whilst simultaneous determinations of the temperature and of the conductivity are made from time to time.

The melting point is determined by a separate experiment. Graetz used this method in the case of a number of substances, and the results which he obtained serve to show that there is in no case a sudden change of conductivity at the melting point.

Tables are given for the conductivity of the following substances: the chlorides, bromides, and iodides of cadmium and zinc, lead chloride, lead iodide, potassium nitrate, cuprous chloride, stannous chloride, and antimonious chloride. These may be consulted in Gilbert's *Annalen der Physik und Chemie*, series [2], vol. xl., p. 18, where the reader will also find the theoretical aspect of the question discussed, particularly in connection with dissociation.

Solutions of the chlorides and nitrates of sodium, potassium and barium, of potassium bromide, chlorate and ferrocyanide, of sodium sulphate, magnesium sulphate and hydrochloric acid, were examined a short time ago by E. Kraunhals, who used an apparatus originally described by Ostwald. In his experiments, Kraunhals investigated the electrical conductivity of solutions of these substances at temperatures between  $18^\circ$  and  $100^\circ$  Centigrade.

The concentration—always, as we have seen, an important consideration in connection with conductivity—varied from 1 gramme equivalent per litre to 1 gramme equivalent per 1,000 litres.

We need not follow Kraunhals through the eight pages of results and deductions from them which he gives in the *Zeitschrift für physikalische Chemie* [vol. v., page 250]; it will be sufficient to state that these results show most conclusively that the higher the temperature the greater the increase in the molecular conductivity with rising dilution.

Kraunhals calculates the mean temperature coefficients for various degrees of dilution, and also the values of  $\mu_\infty$ ; that is, the conductivity for infinite dilution at the temperatures  $18^\circ$ ,  $50.3^\circ$ ,  $82^\circ$ , and  $99.4^\circ$  Centigrade.

The quotient  $\frac{\mu_0}{\mu_\infty}$  is found to decrease somewhat with

rising temperature, from which it is concluded that the influence of temperature on the degree of dissociation of electrolytes which, at ordinary temperatures and in moderately concentrated solutions, are strongly dissociated, is only slight.

The great increase in electrical conductivity with a rise of temperature is explained by Kraunhals by the decrease in the *viscosity* of the solution.

Chemical constitution undoubtedly affects in some way the electrical conductivity of solutions. This is evident from D. Berthelot's researches, recently described in the *Comptes Rendus*, vol. cx., page 703.

The various solutions examined by Berthelot contained 0.01 gramme equivalents of various substances per litre, and the measurements of conductivity were effected by means of a Lippmann's electrometer.

The three hydroxy benzoic acids are observed to possess different conductivities, the resistance increasing in the order—

Ortho-hydroxy benzoic acid			
Meta-	"	"	"
Para-	"	"	"

It is somewhat remarkable that the conductivity of the para-acid is practically identical with that of simple benzoic acid.

When the acids are treated with one equivalent of sodium hydroxide, the numbers obtained are approximately the same in all these cases : thus

Reduction of conductivity for the ortho-acid	=	$\frac{3}{4}$
" " " meta-	=	$\frac{7}{10}$
" " " para-	=	$\frac{2}{3}$

When a second equivalent of the alkali is added, the conductivities of the meta- and para-derivatives remain practically the same, but differ considerably from that of benzoic acid, since the second equivalent of alkali exerts an appreciable effect. A third equivalent exerts a smaller but still appreciable influence.

In the case of the ortho-acid (salicylic acid), the second and third equivalents of the alkali produce less effect than with the meta- and para-derivative. The maximum difference in the case of salicylic acid is reached on the addition of one equivalent of alkali ; but in the case of the meta- and para-acids this maximum is given by the second equivalent.

From these results an interesting chemical deduction has been made, namely, that in the ortho-acid the phenolic function is less energetic than in the meta- and para-acids, a result which agrees with the thermochemical measurements of Berthelot and Werner.

Berthelot first put forward his theory that the examination of electrical conductivity could be used as a means of investigating chemical and correlated physical properties in the *Comptes Rendus*, cix., p. 801, and he showed, for instance, that determination of electrical conductivity could be utilised for determining the condition of equilibrium between dilute saline solution and aspartic acid which combine the functions of a base and an acid.

There is another paper on this subject in the same volume of the *Comptes Rendus*, commencing at page 864, in which the electrical conductivities and the multiple affinities of aspartic acid are investigated.

The most recent work of D. Berthelot on the application of electrical conductivity, to the determination of various chemical facts, may be read in a paper contributed to the *Comptes Rendus*, vol. cx., p. 1,066. In this paper he gives the results of an investigation into the conductivities of the ammonium and aniline salts of the hydroxy benzoic acids.

Those who are interested in this new departure in electro-chemistry may also find a recent paper by C. A. Bischof and P. Walden worth reading. It may be consulted in the *Berichte der Deutschen Chemischen Gesellschaft*, vol. xxiii., p. 1,950. Here is described an investigation which they undertook into the conductivity of the substituted succinic and glutaric acids.

Tables are given showing the melting point and the values, as ascertained by them, of the dissociation constant. It appears that the tri-substituted succinic acids

have the least conductivity, and differ least amongst themselves. In the case of the glutaric acids the differences in the value of the constants were too small to allow of the deduction of any conclusion concerning the constitution of the different acids.

There is also a paper on the conductivity of the substituted succinic acids by Bethmann, in the *Zeitschrift für Physikalische Chemie*, vol. v., p. 385.

## THE VIBRATIONS OF A PLATINUM WIRE KEPT INCANDESCENT BY AN INTERRUPTED ELECTRIC CURRENT.\*

By M. ARGYROPOULOS.

I STRETCHED horizontally a platinum wire .7 of a metre in length and a fraction of a millimetre in diameter, and sent an electric current into it, in order to heat it to white heat. Observing the great dilatation of the wire during the passage of the current, I thought that some vibratory movement would be produced by successive interruptions of the current. I therefore introduced into the circuit a large trembler interrupter, or, better still, the interrupter proposed by Foucault for large Ruhmkorff coils ; the platinum wire immediately began to vibrate, subdividing itself into stationary waves.

We can observe very clearly one, two, three, and as many as eight, ventral segments separated by nodes which seem to be stationary. By very slowly lessening the tension of the platinum wire the number of these ventral points is increased ; on the other hand, if we slowly increase the tension, the number of ventral points is lessened, and the incandescent wire vibrates transversely, forming a single ventral segment in the middle.

The support on which I stretched the wire had two actions, one to stretch the wire more or less, and the other to lengthen or shorten it.

The experiment was performed in the following manner :—First, I took a long length of wire and sent through it a current of from 45 to 50 Bunsen elements, keeping the interrupter inoperative. Then the wire was shortened until it became incandescent. The interrupter was then set in motion and the wire began to vibrate. Then the wire was slowly stretched, until at last it vibrated as a whole, forming one single ventral segment in the middle. By lessening the tension of the wire I could produce as many as eight ventral segments, or even more.

This experiment enables us to illustrate before a large audience the vibratory movements of strings.

## A NEW APPARATUS FOR EXAMINING THE VARIATION OF ELECTROMOTIVE FORCE WITH TEMPERATURE.

A NEW apparatus—or, perhaps, more correctly speaking, a new *method* by means of which the seat of the variation of electromotive force with variation of temperature may be examined—has been devised by a German physicist, A. Gockel. It consists, in its essential features, as follows :—

Four cells are taken and placed at the corners of a rectangle ; these are joined up, according as they are required, along the sides of the rectangle by means of siphons, and filled with certain electrolytes.

The cells at one pair of adjacent corners, for example, contain a solution of zinc sulphate, and are provided with zinc electrodes, whilst the other pair of cells contain a solution of copper sulphate with copper electrodes.

\* Presented to the Académie des Sciences, by M. Cornu.

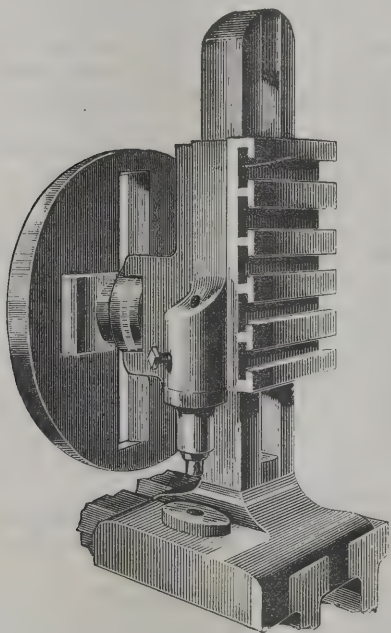
It is obvious that this arrangement gives, practically, two Daniell cells, one of which can be warmed in a water bath, whilst the other remains cold, the necessary connection being made by means of the siphons.

By suitable combination, the temperature co-efficients of the different contacts may be determined. Gockel shows that from these coefficients the temperature co-efficient of the whole galvanic element may be calculated by summation.

It is stated that the agreement between direct experiment and calculation is fairly satisfactory, and this assertion will give confidence to other observers who may be inclined to experiment with this apparatus.

### IMPROVED ATTACHMENT FOR LATHES.

THE apparatus shown in the accompanying illustration will be found a very useful adjunct to a lathe or any similar tool from which a vertical reciprocating motion can be obtained. It consists of a standard which is bolted to the bed of the lathe; upon this slides a grooved face plate, to which is secured the work to be toolled. This face plate is moved up and down by a roller mounted upon a pin bolted to the ordinary lathe chuck plate, which travels to and fro in the roller path formed upon the back of the slide; the length of stroke depending upon the distance of the roller pin from the mandril centre. By placing a cutting tool in the slide rest, and operating the feed screws by hand or by means of self-acting motion obtained from the slide, metals



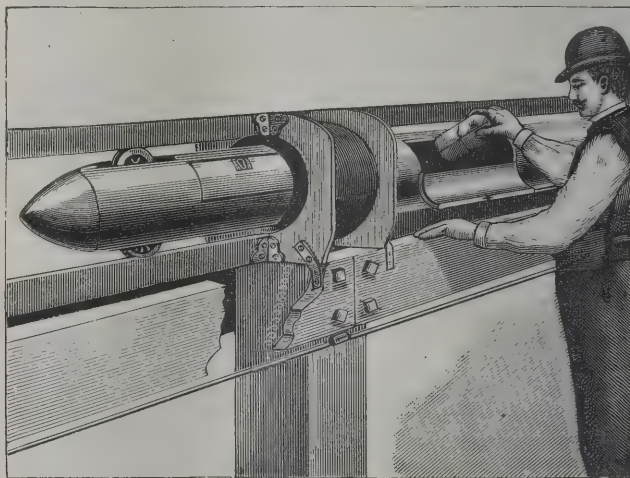
may be planed, shaped, key grooves cut, and a variety of other tooling work accomplished with accuracy and rapidity. For the convenience of light metal workers, a punch and pair of shearing blades can be added for cropping plates and roughing out material. The grooves upon the sliding face plate can, when desired, be replaced by a vice for holding the work, or a vice can be bolted to the grooved face plate. The illustration is taken from an attachment fitted to a 4-inch centre lathe, which has a stroke of three inches; a speed can be obtained of from 50 to 200 strokes per minute. The cost is very moderate. The attachment is patented, the inventor being Mr. F. M. Rogers.

**Department of Science and Art.**—Her Majesty has been graciously pleased to command that the Government institution now known as the Normal School of Science and Royal School of Mines shall in future be called the Royal College of Science, London.

### EXPERIMENTAL PLANT OF THE PORTELECTRIC SYSTEM.

IT is now something more than a year, says the New York *Electrical World*, since the exhibition of the model of the Portelectric system in the Old South Church in Boston. The subsequent description of this promising invention in the daily newspapers and technical journals attracted the notice of people in all parts of the world. It was at once recognised that, could the model be duplicated on a large scale, and be made to work with the same degree of success, its commercial utility and importance in the rapid transportation of mail and express packages would be very great. Since the invention was first exhibited to the public, its projectors have been busily engaged in the construction of an experimental track upon which the "portelectric" car could be tested under conditions similar to those which would be met in actual practice, and fully as severe as those which would be encountered in commercial operation.

This experimental plant, which is located near the Howard Street Station on the New York and New England Railroad, in the suburbs of Boston, has been completed and in experimental operation for some time, but its construction and operation have been open to the inspection of the public only since the 11th of this month. Notwithstanding the difficulties, mostly of a mechanical nature, which necessarily had to be met and overcome in pioneer work of this kind, the experimental work has proved so successful that the performance of the system re-enforces the opinions formerly held by its projectors concerning its future commercial importance.



The system is intended for the transportation not of passengers but of mail and express matter only at rates of speed approximating two miles per minute, the steel car being drawn along its confined path at this high rate by the pull of numerous solenoids through which the track is laid, each coil exerting its power for a short time only as the car approaches it. In general principles the experimental track here described and illustrated does not differ from the model exhibited in the Old South Church last year. In the mechanical details, however, such changes have been made as have been found by actual experience to be necessary to adapt the system to the requirements of commercial service. The method of closing and opening the circuit through the track solenoids at the proper time has been changed; the mounting of the car upon its wheels, the construction of the track and some other mechanical details have been greatly improved. Prof. A. E. Dolbear, the electrician of the company, and Mr. John T. Williams have given the matter almost daily attention for several months, and especial care has been directed toward the reduction, as far as possible, of the copper wire required in the coils of the track solenoids.

The experimental line is nearly 3,000 feet long, built in the form of an oval or somewhat of a pear shape, including two curves of different radii, some straight and level sections, and grades, both on a straight track and on curves. One grade is 8 per cent. and another 11 per cent. Posts 10 inches square are set solidly in the earth to a sufficient depth to be undisturbed by frost, and are packed about with sand. These posts project above the surface to a height of about 4 or 5 feet, and to their sides, at the top, are strongly bolted planks, 3 by 10 inches, set on edge and carefully fitted, so that the top of the planks is flush with the top of the posts. Posts are set at intervals of 6 feet. This low structure was so built simply for convenience of access in conducting experimental investigation.

A very neatly designed and well constructed power house stands directly over the track. The track passes directly through its centre at a distance of about 2 feet from the floor. The building is surmounted by a lookout tower, from which the car may be watched as it speeds around its half-mile course.

The power equipment of the station consists of a Sturtevant 20 H.P. engine and an Edco dynamo to furnish current for the propulsion of the car. This dynamo is wound for a pressure of 1,000 volts. A horizontal tubular boiler supplies steam for the engine and for the heating of the building as well. A small supply and work room is conveniently arranged in one corner of the building. The station is lighted by Bernstein series incandescent lamps, and the track is lighted when necessary with seven arc lights.

Upon the heavy framework of wood of which the track structure is composed are placed the solenoids, a series of coils extending along the entire track at intervals of 6 feet. These coils have an internal diameter of 11 inches, and are each made of about 20 lbs. of No. 14 wire. The two rails of the track extend through these coils, one at the top and the other at the bottom. The lower track is in connection with one terminal of the dynamo and the other terminal is connected with a lead wire parallel with the lower track. To this wire are attached branches connecting it to the various sections of the upper track, these sections being about six feet long. The passage of the car completes the circuit between the upper and lower rails through the solenoid in advance of the car, and the car is thus pulled into the coil until it is midway through the coil, when the current is cut out and transferred to the next coil in advance.

The car is an iron cylinder 10 inches in diameter and, with its conical ends, is 12 feet long and weighs 350 lbs. It runs on two wheels, and also has guide wheels to run on the track above the car. Doors upon its side allow of the necessary matter constituting the load of the car to be placed upon its inside and securely locked in place.

The greatest difficulty experienced in the operation of this track and car was in the adaptation of the car to the compound curve, made up of a grade and a curve of short radius. It was found necessary to make the car itself rotate to accommodate itself to the curve and grade; thus introducing a great frictional resistance. In spite of this, however, the car has been drawn about the oval track in about  $1\frac{1}{2}$  minutes, and its speed has reached about 45 feet per second. The greatest acceleration observed was about  $3\frac{1}{2}$  feet per second, which, if maintained for a minute would give a speed of about two miles per minute. The shape and difficulties of the present track, however, prevent the acquiring of such a speed.

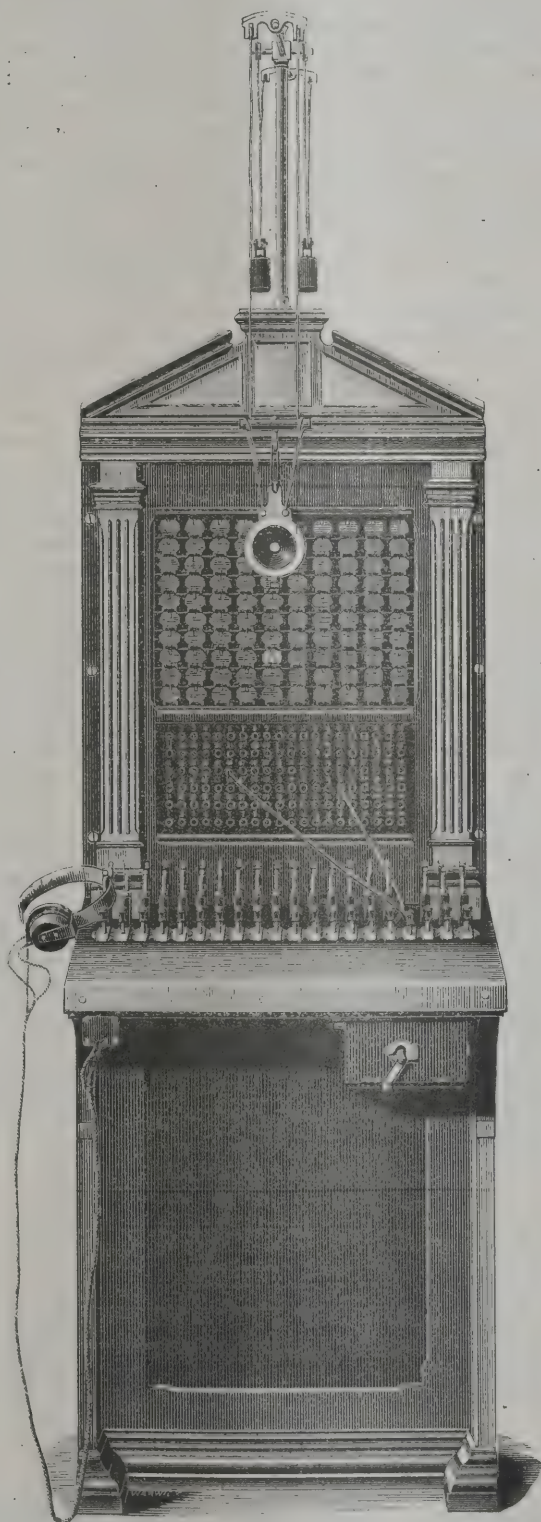
In forming an opinion of what has been already accomplished by the plant described above, it should be borne in mind that the whole project was so new that every step has had to be taken without the assistance of any precedent, or of the experience of others in similar work. Its growth, however, has been very satisfactory, and Prof. Dolbear asserts that there is every reason for thinking that in a short time the car will be capable of running away from the swiftest express train.

## IMPROVEMENTS IN TELEPHONE EXCHANGE SWITCHBOARDS.

By J. E. KINGSBURY.

THE subject of improvements in telephone exchange switchboards is of so much interest and importance that it cannot well be left at the point reached in the article on the subject last week.

I may first say that switchboards for small exchanges have not been neglected in the way the writer of the



article supposes. All the improvements in details which have been made in connection with multiple boards have been applied to the smaller boards so far as practicable, but it is quite true that the type of board remains very much what it was many years ago. I find this, however, simply a tribute to the prescience of its designers. The type I refer to is what is known all

over the world as the "Standard" switchboard, in which the two subscribers' indicators are cut off, "left idle," and a special ring off indicator inserted in the circuit of the pair of cords with which connection is made. This type of board is made from 25 subscribers upwards, for telephone exchange use. Smaller switchboards are not usually fitted with clearing out drops, but nevertheless only one of the subscribers' drops is left in circuit. The question of switchboards for exchanges is a large one and I cannot hope to do more than touch the fringe of the subject, but it is important that those of your readers who are not practical telephone men, and yet interested in telephony, should not be led to an incorrect conclusion by reason of the way in which the subject was dealt with last week.

A switchboard cannot be judged by itself. It is, or will be, one of a series making an exchange, and the exchange in its turn is, or will most likely be, one of a number constituting a telephonic system. A switchboard, then, must not only work well with the number of subscribers for which it is fitted, but must also be so arranged that further sections may be easily added as the subscribers increase; the whole work smoothly and quickly; and the electrical conditions be such as will interfere as little as possible with conversations from distant places.

The switchboard shown last week has a frontage of about 2 feet 6 inches. By the time the exchange had reached 120 lines there would be 4 sections covering a distance of 10 feet. Subscriber No. 1 would be on the extreme left, and No. 120 on the extreme right. If those two numbers were required to be connected, it could not be done with one operation. The cord is not sufficiently long, and if it were there are three other operators in the way. "Cross connections" therefore would be provided between the different boards, the work of connecting doubled, and the risk of error increased by the call passing through two hands. This system of cross connection is unavoidable in non-multiple exchanges, but in no case should it ever be necessary with so small a number as 120 subscribers. I would like to point out that it is not necessary to cover so large a space. The boards may be more compressed, but then the plugs are crowded. It is a choice of evils.

This type of board fails when considered as part of a series. Not only so, but it fails to come up to what is claimed for it when considered singly. The description says that because it only requires the plug of any line to be inserted in the jack of any other line to make a connection, it is plain that much less work is necessary than if a cord with a plug at each end of it were to be used for the purpose. At first sight it does seem so, but it is a fallacy nevertheless. Further on in the article the movements required are given in detail, and I transcribe them below in comparison with the movements required to make a connection with the board illustrated here, which is a double cord board:—

SINGLE CORD.		DOUBLE CORD.	
Insert general plug in No. 5 jack	1	Insert first plug into No. 5 jack (the operator's telephone is then in the line)	1
Take out general plug from No. 5 jack	1	Insert second plug into No. 10 jack and ring	1
Insert general plug in No. 10 jack and ring	2	Throw over lever of speaking key (which connects the two subscribers and disconnects the operator)	1
Insert No. 10 plug into No. 5 jack	1		
Take out general plug from No. 10 jack	1		
Total	6	Total	4

Instead of much less work being necessary, two movements more are necessary to make a connection on the single than the double cord board. The making of a connection is not all the work. The connection has to be unmade, and a comparison is not fair which does not include that also. When this is considered, the movements are equal in number, the single cord board requiring only one plug to be pulled out (1), whilst the double cord requires two plugs to be pulled out and a speaking key to be thrown over (3). It is not

to be supposed that these movements, though of equal number, are of equal value. The double cord movements are done much more quickly.

I think this will suffice to show that the saving of 30 per cent. in operators' work, which is claimed, is quite illusory, the balance is the other way.

But if there be no saving in operators' work, wherein consists the "Improvement"? It is not in facilities offered in other directions, for there are none. It is not in economy of first cost, for more material is used. It is not in saving of operators' wages, for the same number of subscribers takes a larger number of operators than a double cord board.

I am aware that there are advocates for these boards whose opinions are entitled to respect, but, unfortunately, opinion may be set against opinion. There is, probably, no subject which it is less safe to dogmatise upon than telephone switchboards. Circumstances do, undoubtedly, alter cases, and should be taken into account; but there are certain all-round requirements which have to be met, and it ought to be possible to demonstrate with reasonable precision in what way these boards are superior in design to their predecessors. The demonstration is not contained in last week's article. If I were to point out all the short-comings of the board and the errors of statement and deduction in the article, I might give the impression that my criticism was of a captious character; whilst, on the contrary, I am desirous only of contributing a few items of interest on a general question.

The board here illustrated is one of a type which the writer of last week's article does not allow for, *i.e.*, a double cord board without special clearing out drops, and yet only one drop left in circuit. It is for 100 subscribers, and is 23 inches wide. Thus 500 subscribers would occupy a space of less than 10 feet. It has some advantages, though in principle it is not better than the special clearing-out drop type. This latter enables the most suitable drop to be used for respective purposes, *i.e.*, those which would interfere with talking are "left idle," those which do not deleteriously affect talking are left in circuit. The designers of the standard switchboard recognised the fact which has been overlooked by their critics, that a telephone switchboard needed something more than a line of communication between one subscriber and another, and concluded that the most suitable place for the necessary apparatus was in the circuit of a pair of connecting cords. It is the absence of this necessary apparatus which makes the particular form of single cord board in question, clumsy in operating. If it were present, it would take up more room, and while increasing the cost, nullify the advantage. And here, I may say, that a single cord multiple board and the type of single cord board under discussion, are two distinct things. In the multiple board there is key-board room for all the apparatus needed and the apparatus is there.

## EDINBURGH EXHIBITION.

(Continued from page 407.)

"Silvertown" Dynamo and "Globe" Compound Engine.—The dynamo, which is capable of giving a continuous output of 350 ampères and 104 volts at 300 revolutions, has been designed for coupling direct to a high speed engine, and is so coupled to a Globe compound engine having cylinders  $8\frac{1}{2}$  inches and 15 inches diameter, by 8-inch stroke. The magnets are of the single horseshoe type, with pole pieces at the lower end, each vertical limb carrying a metal bobbin, on which is wound both series and shunt wire. The armature, which is of the ring type, has its core built up of thin annealed charcoal iron discs, insulated from one another by every alternate disc having a thin coating of special ebonite cured on. The discs are keyholed,

and carried by a four armed gun metal spider which, in turn, is securely keyed to the steel shaft. The armature winding consists of one layer of insulated strand cable, wound and connected on in the ordinary method to the commutator, which is built up of hard drawn copper segments, insulated with mica, and carried at each end by insulated gun-metal rings, fitting into grooves, turned in the commutator. The insulation of this ring is obtained by the use of ebonite, which is cured on to this ring to a thickness of about  $\frac{1}{8}$ th of an inch; and it has been found that this method has given much more satisfactory results than the old one of having separate insulating pieces. The rings fit on to a gun-metal sleeve, bored to fit the shaft, and the whole commutator is screwed up tight by nuts on this sleeve, so that it is complete in itself. There are three brush-holders on each spindle, each fitted with separate adjustments for pressure, and with hold-off catches. The brushes and holders are made of ample section, and each brush-holder is connected by a separate flexible conductor to the terminal board of the machine, to avoid the necessity of collecting the current through the contact between the holder and the spindle on which it is carried. The dynamo has been designed for continuous running in an engine room, the temperature of which is somewhat over 100° Fahr., and the rise of temperature has therefore been kept low; an actual test, made by placing the thermometer on the armature directly the machine was stopped, and noting the highest temperature recorded by the thermometer, showing a rise of 25° Fahr.

## REVIEWS.

*The Working and the Connections of Electric Telegraphs.* Compiled by Prof. Dr. KARL EDUARD ZETZSCHE, Engineer of Imperial Telegraphs, with the co-operation of several specialists; being, at the same time, the second half of the third volume of the *Manual of Electric Telegraphy*. Part 2, Section 3; *The Arrangements and Connections for Multiple Telegraphy*. Drawn up by Dr. A. TOBLER and Dr. E. ZETZSCHE. Halle on the Saale: W. Knapp.

The authors of this treatise deal with their subject in the most thorough-going manner. In the third section, with which the present volume begins, they explain the kinds of multiple telegraphy. They distinguish duplex telegraphy, *i.e.*, the simultaneous dispatch of two telegrams in opposite directions on the same line; diplex-telegraphy, the dispatch of two telegrams on one and the same line, but in the same direction, and, lastly, quadruplex-telegraphy, the dispatch of two telegrams on the same line in each direction. As regards the economical value of multiple telegraphy, it is remarked that in spite of the great number of devices proposed the system has not met with such wide application as might have been expected. There seems little prospect that as many messages can be dispatched by duplex telegraphy on a single wire as can be sent upon two wires by simple telegraphy.

The authors describe in the first place the duplex telegraphs for short lines, then those for long aerial lines, and, lastly, those suitable for cables. Under each of these heads the various kinds of instruments are described and shown in beautiful figures.

In duplex telegraphy in long aerial lines, well insulated, and still more in cables, the phenomena of charging constitute an obstacle.

Intermittent multiple telegraphy is discussed at great length, with special notice of the systems of Laborde, Munier, Brown, and La Cour. The work is evidently incomplete, the appearance of the concluding part being promised by the end of the current year. Still, we can have no hesitation in pronouncing it a treatise of great value to telegraphists and to electrical engineers in general.

*Practical Manual of the Installation of the Electric Light* (*Manuel pratique de l'Installation de la Lumière Electrique*). Par J. P. ANSEY, Electrical Engineer. Paris: Tignal.

This manual, after general rules for installation, treats of motors and their possible defects. Steam engines, gas engines, petroleum engines, hot air, compressed air and water power, are all described. Compressed air, on the system of Popp, seems to find considerable favour in Paris. Next follows a description of electrical machines, with an account of the properties which they ought to possess. We have then the installation, maintenance and care of the machines. Accumulators are described especially as adapted for lighting purposes by the Electrical Power Storage Company. The rest of the work is devoted to arc lamps, the Jablochhoff candle, glow lamps, and accessory appliances, the arrangement of the leads, special installations, *e.g.*, those of powder works, distilleries, mills, ships, light-houses, and theatres.

A special chapter lays down the duties of the various officials engaged in electrical works, and an appendix gives an abstract of the French laws, on the introduction and regulation of the electric light in theatres, music halls, &c.

The work is illustrated with 135 figures in the text, many of which, we are sorry to say, are strikingly bad.

*Traité D'Electricité et de Magnetisme; théorie et applications; instruments et methodes de mesure electriques. Cours professé à l'Ecole Supérieure de telegraphie.* By A. VASCHY, Ingenieur des Telegraphes, Répétiteur à l'Ecole Polytechnique. Vols. 1 and 2. Paris: Librairie Polytechnique, Baudry et Cie, 15, Rue des Saints-Pères.

These two volumes form an excellent treatise on electricity and magnetism. Theory, properly so called, forms the subject of the first volume; elementary principles are not dealt with, these being supposed to have been previously studied by the reader. In the second volume the application of electrical laws to telegraphy, telephony, and other subjects, is considered, electrical measurement being more particularly dealt with. The books being especially written for students studying telegraphy, the subjects of electric lighting, dynamos, &c., are not touched upon; we say "written for students studying telegraphy," but we imagine that this is only nominally so, for the nature of the whole treatise is far too deep to be of any practical value to an ordinary student, it being somewhat on a par with the "Electricity and Magnetism" of Clerk Maxwell; in fact, we should say that it is the very last work to recommend to such students. Generally speaking the two volumes may be described as a very excellent "boil down" of matter which is found scattered through numerous modern works, though we by no means say that there is not a good deal of original matter also. Although frequent references are made to authorities in foot notes, there is a very great deal of original information obtained from standard works of which no acknowledgement whatever is made. The author has taken great pains to keep to the front by giving the very latest information, and he does not deal with individual subjects at too great a length. Altogether we must express ourselves as much pleased with Mr. Vaschy's production, which does him great credit.

*Dictionnaire d'Electricité et de Magnetisme.* By JULIEN LEFEVRE. 2nd issue. Paris: J. B. Baillié et Fils, 19, Rue Hautefeuille.

We expressed a distinctly favourable opinion on the 1st issue of this dictionary; the 2nd issue commencing at "Electrolysable," and terminating at "Magnetometre," is equally good with the first. The whole work promises to be a very valuable compilation when complete.

*Tables to find the Working Speed of Cables, comprising also Data as to Diameter, Capacity, and Copper Resistance of all Cores.* By ARTHUR DEARLOVE. London: E. & F. N. Spon, 125, Strand.

Although but few books dealing with the subject of the electric telegraph are now issued, the subject of the electric light and the application of electricity for the purpose of power having carried all before it, yet occasionally productions are issued dealing with particular points in connection with telegraphic communication, some of small value, others of distinct utility. The small pocket-book before us decidedly belongs to the latter class. Up to the present, practically little reliable information has existed which was available when it was required to estimate what working speed could be obtained through a proposed cable of a particular type, or to estimate what type would be required to obtain any particular speed. This very necessary information can now be obtained with certainty by means of Mr. Dearlove's useful tables. The latter have been compiled from formulæ which have for some time been used by Messrs. Clark, Forde and Taylor (names which are a guarantee for correctness on a subject of the kind in question), and are based on mean results recently obtained in the commercial working of long cables. The starting point upon which the calculations are based are: 1st, the capacity of a cable whose conductor and dielectric are of equal weights is 355 microfarad per knot. 2nd, the temperature of a laid cable is 45° F., at which temperature each knot-pound has a resistance of 1,124 ohms. There are actually two tables in the book, the first giving all data with reference to cores of from 100 lbs. copper and 80 lbs. gutta percha to 500 lbs. copper and 500 lbs. gutta percha, the former giving, it may be mentioned, a speed of 26.6 words per minute (over a length of 1,000 knots), and the latter a speed of 147.7 words per minute. The second table gives dimension coefficients for various lengths of cable up to 4,000 knots, by which the working speed given in Table I. have to be divided. Of course in practice a clerk cannot read on a mirror instrument at a greater speed than about 25 words per minute, so that it is not to be understood that where a greater speed than this is shown by the calculations, this speed can actually be obtained, but only that the particular cable in question has a larger core than is necessary. This point might perhaps be shown a little clearer in the explanatory introduction, as it is liable we, think, to mislead. By the use of automatic transmitters and receivers very high speed working is possible under certain conditions. It would be interesting to know what this speed would be in practice on a 1,000-mile cable with 500 lbs. copper and gutta-percha, and which is calculated to give, with an instrument as sensitive as the mirror, a speed of 147.7 words per minute.

## BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.—LEEDS, 1890.

### EXPERIMENTS TO DETERMINE WAVE VELOCITY IN CERTAIN DIELECTRICS.

By F. T. TROUTON.

(Read before Section A, September, 1890.)

THE method employed was described in *Nature*, February 21st, 1889, and depends essentially on interposing a sheet of the dielectric between the reflector and the resonator in Hertz's well-known experiment of electro-magnetic "loops and nodes." The effect of this is to move in towards the reflector the system of maximum and minimum sparking positions. The amount of the displacement thus resulting depends on the rate of propagation of the disturbance through the dielectric sheet.

In the experiments made the sheet was placed immediately in front of the reflector. The circular form of resonance was employed to determine the position of the "loops and nodes," and it was always held so as to be only effected by the magnetic component.

If the reflection, which occurs at both surfaces of the sheet, be neglected, ( $\mu$ ) the index of refraction will be found by dividing ( $l$ )

the thickness of the sheet into its air equivalent  $\mu = \frac{(x_0 - x)}{l}$  where  $x$  is the distance from the sheet to the first node or magnetic minimum position, and  $x_0$  the distance of the node from the reflector when the sheet is removed—that is to say, one-quarter the wave-length in air.

When the reflection from the surface of the dielectric is considered the expression for  $\mu$  is not quite so simple. If we suppose the metallic reflector in optical contact with the dielectric sheet, we can then sum up the multiple reflections resulting very much as in the well-known way of doing so for Newton's rings. Let the amplitude of the incident radiation be taken as unity, and let  $b$  be that of the reflection at the front surface of the sheet, and  $c$  of the part penetrating. This portion on reaching the metallic reflector is supposed returned, and at the front of the sheet is again divided; let the part reflected back to the metal be  $ce$ , and that sent out  $cf$ , and so on. The reflected wave is found by summing up these terms. If  $\sin \phi$  is taken to represent the incident radiation at the front surface of the dielectric, the total reflection then is  $b \sin \phi + cf \{ \sin(\phi + \delta) + \epsilon^2 \sin(\phi + 2\delta) + \epsilon^4 \sin(\phi + 4\delta) + \dots \}$ , where

$$\delta = 2\pi l \mu, m \text{ standing for } \frac{2\pi}{\lambda}. \text{ This can be written as } A \sin(\phi + 2m\pi r), \text{ when } \tan 2m\pi r = \frac{(1 - b^2) \sin \delta}{(2b + (1 + b^2) \cos \delta)}. \text{ This gives for } \mu, \text{ remembering that } b = \frac{(\mu - 1)}{\mu + 1}; \tan 2m\pi r = \frac{2\mu \sin 2m\pi l}{(\mu^2 - 1) + (\mu^2 + 1) \cos 2m\pi l}.$$

Here  $r$  is the equivalent distance in air, or  $r = x_0 - x$ .

Some experiments have been made with sheets of pitch, solid paraffin, sulphur, and plaster of Paris. In the case of pitch, the value of  $\mu$  calculated from the above results is about what would be expected, namely, about 1.7 (Hertz by means of his pitch prism found 1.69); but in the case of the others the calculated values of  $\mu$  are evidently much too large, those for paraffin and sulphur lying between 3 and 4. The area of the pitch sheet was 60 by 45 c., that of the paraffin and sulphur 60 by 29 c.; the thicknesses were 6.3, 3.5, and 3 c. respectively. The zinc reflector placed behind the sheets was the same size as the sheets. It may be due to the small sizes employed that these unsatisfactory results were obtained, the small size of the reflector introducing diffraction phenomena—that is to say, the first node is situated at more than  $\lambda/4$  from the reflector. This is due to the electrically-charged edges of the metal reflector. This is more fully referred to in *Phil. Mag.*, March, 1890. An approximate calculation of the action of such a reflector can be obtained by supposing it equivalent to a Hertz vibrator; in this way are obtained values for the velocity of the disturbance near the reflector greater than the normal. It may possibly be that these abnormal velocities (or whatever may be the true phenomenon which is equivalent to such) are effected in a greater ratio than the normal velocity is by the substitution of other dielectrics for air. In fact, taking Hertz's value for the

velocity at distance  $v$  as  $v = \sqrt{\frac{m^2 v^2 + 1}{m^2 v^2}}$ , we find something of the kind. For a dielectric whose index of refraction is  $\mu$ ,  $v_1 = \sqrt{\frac{m^2 v^2 \mu^2 + 1}{m^2 v^2 \mu^2}}$ ; and the value of the index at distance

$$v, \mu_v = \frac{v}{v_1} = \mu \left( \frac{m^2 v^2 + 1}{m^2 v^2 + \frac{1}{\mu^2}} \right). \text{ This gives } \mu_v \text{ as greater}$$

than  $\mu$  the normal value.

It must, however, be remembered that at the distances in the present case the formula can hardly be satisfactorily applied. The thing might be experimentally tested by placing the sheet at a little distance in front of the reflector. There is no question but that the employment of larger dielectric sheets and metal reflectors, so as to give the equiphasial surfaces plane instead of curved, will be the best solution of the main enquiry.

When there is a space left between the dielectric sheet and the reflector, the calculation is more complicated than before, owing to the reflection from the back of the dielectric as independent of the metal. In the following this distance is supposed nothing but the back reflection from the sheet left. The result can be written

$$\text{as } \tan 2m\pi r = \frac{A \sin \alpha + c \sin \gamma}{A \cos \alpha + c \cos \gamma}, \text{ where } A \text{ is the amplitude of}$$

the reflection from the dielectric sheet alone, the metal being removed, and  $\alpha$  the alternation in phase introduced; and where  $c$  is the amplitude of the point resulting from replacing the metal reflector, and  $\gamma$  the alteration in phase belonging to it.  $A$  and  $\alpha$  are found precisely as in Newton rings.

$$A^2 = \frac{2b^2(1 - \cos \delta)}{1 - 2b^2 \cos \delta + b^4} \tan \alpha = \frac{b^2 - 1}{b^2 + 1} \cot \frac{\delta}{2}.$$

To find  $c$ , let the transmitted beam be written as  $B \sin(\phi + \beta)$  when

$$\tan \beta = \frac{\sin \delta}{\cos \delta - b^2},$$

and suppose this returned by the metal reflector. Part of this will be transmitted by the sheet, and part sent back a second time to the metal. The part transmitted is  $B^2 \sin(\phi + 2\beta)$ ; the part reflected back to the metal is  $A B \sin(\phi + \beta + \alpha)$ . This is again reflected by the metal, and is again divided up. The part trans-

mitted is  $A^2 \sin(\phi + 2\beta + \alpha)$ ; the part reflected is  $A^2 \sin(\phi + \beta + 2\alpha)$  and so on. Then we have to solve

$$c \sin(\phi + \gamma) = B^2 \left\{ \sin(\phi + 2\beta) + A \sin(\phi + 2\beta + \alpha) + A^2 \sin(\phi + 2\beta + 2\alpha) + \dots \right\}$$

and summing up we get the values of  $c$  and  $\gamma$ . Putting in for the sines their exponential values and recollecting that  $B^2 = (1 - A^2)$

$$\text{we get } c^2 = \frac{(1 - A^2)^2}{1 - 2A \cos \alpha + A^2} \text{ and } \gamma = 2\beta + \tan^{-1} \frac{A \sin \alpha}{1 - A \cos \alpha}.$$

The calculations of  $\mu$  from this result is practically the same values as given above. In the case of some substances it was found quite impossible to make a determination of  $\mu$  after the method described, as they afforded of themselves such strong reflection. Glass even 2 c. thick gave considerable reflection, as did also a limestone flag 2.5 c. thick. Slate and sandstone gave reflection, but not so strong as the other two. A sheet of coal 2.5 c. gave very slight reflection, but a sheet of thin battery carbon reflected like metal. No reflection could be obtained from ebonite 2.5 c. thick, shellac 2 c., or tallow, pitch, paraffin, or sulphur. This reflection is doubtless due to absorption of the beam reflected from the back surface, which thus weakened cannot sensibly interfere with that from the front surface. Owing to the nature of the apparatus and the fact of its constantly changing in sensitiveness, no precise measurements are possible, but a considerable number of comparisons between different substances were made in this wise. The resonator was set so as to only just spark on placing, say, a sheet of glass behind it as reflector, then quickly a sheet of, say, sandstone, and again glass. In this way it could be found that while glass caused sparking the sandstone did not. A cell (adjustable as to thickness) made of cardboard, which could be filled with various substances in a broken up state, such as quartz, sand, chalk, lampblack was tried. When 2 c. thick no reflection, or hardly any, was found with sand, fair reflection with chalk, and lampblack gave as "good as the limestone flag." Before the chalk was well dried it seemed to give stronger reflection. These sheets were about 1 foot square. Some quantitative method, such as that used in Germany by Rubens and Bitter, but which could be applied on a small scale, would be desirable, for these experiments are necessarily of the very roughest sort.

## LONDON COUNTY COUNCIL.

THE weekly meeting was held on Tuesday at Spring Gardens, Sir John Lubbock in the chair.

The Highways Committee reported that they have considered the question whether the council should be advised to again attempt to obtain control over the overhead wires in the County of London. It will be in the recollection of the council that the Bill introduced for this purpose last session was, after having been amended and passed by the select committee, rejected by the very small majority of three in the House of Commons, the voting having been 200 for and 203 against, notwithstanding that the chairman of the Select Committee and the chairman of Committees of the House fully explained the Bill, and supported the decision of the Select Committee. The committee are of opinion that the Bill, having received the approval of a Select Committee, should be again submitted for the consideration of Parliament, and they therefore recommend—

That the council's Bill relating to overhead wires, in the form in which it passed the Select Committee of the House of Commons, subject, however, to such modifications as the Parliamentary Committee may consider necessary, be again introduced into Parliament next session; and that it be referred to the Parliamentary Committee to give the requisite notices, and to take other measures necessary for the purpose.

The committee have considered three notices of the London Electric Supply Corporation, as follows—

6th October, 1890 (Registered No. 120), of intention to lay distributing mains in Waterloo Bridge Road and Westminster Bridge Road (1 plan).

6th October, 1890 (Registered No. 121), of intention to lay distributing mains in Westminster Bridge Road, Waterloo Road, Borough Road and Borough High Street (1 plan).

6th October, 1890 (Registered No. 122), of intention to lay distributing mains in Blackman Street, Newington Causeway, Newington Butts, and Walworth Road (1 plan).

These notices relate to works of the same character as those approved by the council on previous notices of this company; and the committee recommend—

That the sanction of the council be given to the works referred to in the notices (Registered Nos. 120, 121 and 122), each dated 6th October, 1890, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's engineer before commencing the work; that the mains be laid under the footways, and be kept 9 inches below the under side of the pavement, wherever it is found practicable to do so; and that where the mains cross the carriageways they be kept at the same depth below the concrete, or the road material, as the case may be.

The committee have also considered a notice, dated 9th October, 1890 (Registered No. 123), from the Notting Hill Electric Lighting Company, of intention to lay three 2-inch pipes across Holland

Park, from No. 39 to No. 76 (1 plan); and a further notice (Registered No. 124) from the company, bearing the same date, of intention to lay a 15-inch culvert on the east side of Pembridge Gardens, from No. 4, Pembridge Square to No. 74, High Street, Notting Hill (1 plan), in substitution for the works in Pembridge Gardens already sanctioned by the council (Registered No. 108). The proposed works appear to be unobjectionable; and the committee recommend—

That the sanction of the council be given to the works referred to in the notices (Registered Nos. 123 and 124) of the Notting Hill Electric Lighting Company, each dated 9th October, 1890, upon condition that the company do give two days' notice to the council's engineer before commencing the work; that the cover-stones of the culverts under 20 inches wide shall be not less than 2 inches thick, and of the wider culverts not less than 2½ inches; and that, where the culverts cross the carriageway, there shall be at least 9 inches thickness of Portland cement concrete above the cover-stones of the culvert, in addition to the road material.

The Kensington and Knightsbridge Electric Lighting Company has given a notice (Registered No. 125), dated 8th October, 1890, of an intended small extension of mains in Hyde Park Gate (1 plan). There appears to be no objection to this; and the committee recommend—

That the sanction of the council be given to the works referred to in the notice (Registered No. 125) of the Kensington and Knightsbridge Electric Lighting Company, dated 8th October, 1890.

## NOTES.

**The Electric Light in Barcelona.**—The electro-technical journal *Los Anales de la Electricidad*, of Madrid, does not look very favourably upon the scheme for lighting (7,000 incandescence lamps), the town of Barcelona by means of Ferranti dynamos, working at 10,000 volts, underground cables, and transformers. The high potential is objected to because, it is said, that the Deptford scheme has not yet proved a success, and underground cables are taken exception to, such a system being next to impossible in Barcelona where no large sewers exist, and where the ground under the narrow streets contains a perfect network of gas and water pipes, and small drains.

**The Electric Light at Bournemouth.**—At a meeting of the Bournemouth Commissioners last week a letter was read from Messrs. Learoyd, James & Mellor, applying for consent to a provisional order being granted to their client's, The National Electric Supply Company, Limited. A committee recommended that consent be given, subject to the order being approved by the Commissioners. It was stated that there were already two companies with provisional orders, one of whom, however, had made no sign of acting upon it. The matter was referred back to the committee. A letter was read from the Brush Electrical Engineering Company, intimating their intention of shortly commencing to lay their wires underground.

**The Electric Light in Cornwall.**—The Penzance Town Council have been asked to accede to the application of the Penzance Electricity Supply Company, for the grant to them of a provisional order, but after consideration they have adopted the recommendation of the Lighting Committee, that the Council should themselves take steps to obtain an order with a view to entering into a contract with a company to carry out the works.

**Croydon and Electric Lighting.**—The town authorities are making application for a provisional order.

**A Generous Bequest.**—The late Dr. Muirhead, of Lanarkshire, has left the bulk of his estate to be applied to founding and maintaining an institution to be called the Muirhead College for the instruction and education of women in medical and biological sciences, whereby they may be trained to become medical practitioners, dentists, electricians, and chemists. The testator appointed fourteen ladies and gentlemen as executors. It is expected that the estate, which is chiefly in land, will realise about £30,000.

**The Argentine Cables.**—The journal *La Nacion*, of Buenos Ayres, contains a paragraph concerning the concession of the proposed cables between the Argentine Republic and Europe. As many of our readers have a certain interest in this scheme, we translate the paragraph for their benefit:—"Bieckert and Company's Cables.—On the occasion of the drawing up of the final deed of contract referring to the concession which, by the law of the 8th November, 1889, was obtained by Messrs. Emilio Bieckert & Co. for the laying and working of a telegraph cable to Europe, a difficulty was met with, which may result in the annulling of the contract signed by ex-President Juarez. This circumstance should not be necessary in order to induce the Government to abandon an enterprise which, at a cost of 11 millions of gold dollars, bearing an interest of 5 per cent., lays a burden upon the national treasury. The condition to which a spendthrift administration has brought the country does not sanction the contracting of engagements of this nature, more especially since there already exist abundant facilities for telegraphic communication with the whole world. The entering into contracts of this kind would be a repetition of censurable actions, and would produce the most adverse expressions of opinion. The present administration, which is waging war against dishonest *employés*, will, we are sure, continue it with the greatest determination against those concessions whose aim is the building up of private fortunes at the expense, and to the ruin, of the interests of the community."

#### Recent Interruptions and Repairs to Submarine Cables and Land Lines:—

Cables;	Interrupted.	Repaired.
Suakim—Perim ... ..	12th Sept. 1890.	Still interrupted.
Louveau—Marquez and Durban ... ..	15th Oct., 1890.	16th Oct., 1890.
Cape St. Jacques (Saigon) and Thuanan (Huë) ... ..	21st " "	Still interrupted.
Land-lines.		
Guatemala ... ..	26th July, 1890.	7th Oct., 1890.
Moulmein—Bangkok ... ..	4th Oct., " "	8th " "

**Communication with Turks' Islands.**—The Halifax and Bermuda Cable Company has issued a notification in which it undertakes to transmit by post telegrams for Turks Islands (West Indies), which may be sent *via* Bermuda. The telegrams will be posted at Bermuda on or about the 18th of each month, and an additional charge of one shilling per postage will be made on each telegram. The words "Post Bermuda" should be added to the address of every telegram.

**Increase of Plant at Bradford.**—To meet the increasing demands for the electric light at Bradford the Corporation is now having an additional Willans's engine of 300 I.H.P. put down. The engine is coupled direct to a Siemens's dynamo capable of developing 240 E.H.P. The new work is being carried out by Messrs. Siemens Brothers, and the same firm has also in hand the laying down of additional feeding and distributing mains. A set of storage cells is also being supplied. These have been supplied by Messrs. Crompton, Howell & Co., and they have a capacity of 1,000 ampère hours. These cells are intended to meet whatever demand there may be for light in the still hours of the night and morning. At 10 a.m. they will be thrown out of use by the starting of one of the engines and dynamos, and in the evening, when the demand for light is at its height, the corporation, during the coming winter, will be in a position to turn on four engines and dynamos, the united output of which will equal 600 E.H.P.

**Advice Gratis.**—In a leaflet which the "Medical Battery Company, Limited," gets inserted in a number of "serious" journals, we read:—"Beware of Bogus Appliances." Perhaps Mr. Harness, or some one of his physicians, surgeons, and electricians has by mistake put on the magic cap, which had the inconvenient property of causing its wearer to speak the truth.

**The ss. "Silvertown."**—This cable ship, which left the Thames on October 11th, arrived at Las Palmas, Gran Canaria, on October 18th. She left this port, after coaling, on October 19th, for Valparaiso.

**The Arc Musical Society.**—This society, composed of members of Mr. Ronald Scott's works at Acton Hill, opened its second season of smoking concerts on the 21st inst., at the Lyric Hall, Ealing, the concert being preceded by a dinner to which nearly 60 sat down. Mr. A. H. Tripp, the popular and ever energetic honorary secretary, to whom a vote of thanks was proposed by Mr. Scott, received quite an ovation, the general success of the society and of the dinner that night being entirely due to Mr. Tripp's personal exertions.

**Owen's College, Manchester.**—A prize of £10 has been offered by Mr. William Mather, M.P., for the best essay on some subject connected with the technical application of electricity, the competition being open to students working in the physical laboratory of the Owen's College during the day or evening. The award is to be given at the end of the present session, and Dr. Edward Hopkinson has offered a similar prize, to be awarded next session. The subject for the present session is "Recent Progress in the Science of Magnetism."

**The Southampton Electric Light and Power Company, Limited.**—At the last meeting of the Southampton Town Council, a letter was read from the Board of Trade, enclosing a letter from Messrs. Deacon, Gibson and Metcalf, of 4, St. Mary Axe, London, stating that the nominal capital of the company is £30,000, divided into 4,000 preference and 2,000 ordinary shares of £5 each. 577 ordinary shares had been taken up, and on these £1,071 had been paid. The company had issued debentures to the amount of £2,100 for the purpose of satisfying liabilities under a contract between the company and Crompton & Co, Limited, for the supply of plant and mains for the purposes of the undertaking. The only liabilities of the company were the solicitors' costs to date, and the liabilities under the above-mentioned contract. The Board of Trade asked for any observations the council might wish to make, and the letter was referred to a committee. It was stated that the company had already commenced the work, and that everything would have to be done to the satisfaction of the borough engineer.

**Presentation to Mr. A. R. Bennett.**—On October 23rd a deputation, consisting of about twenty of the National Telephone Company's *employés* in Scotland, comprising all the principal district managers and engineers, waited on Mr. Bennett and presented an illuminated address, recapitulating his services to the company during the eight years of his administration as general manager of their affairs in Scotland, and expressing regret at his resignation and good wishes for the future. The address was accompanied by a costly set of Sir William Thomson's electrical testing apparatus, manufactured by the India-Rubber, Gutta-Percha, and Telegraph Works, of Silvertown. The presentation was acknowledged by Mr. Bennett in suitable terms, and he was afterwards entertained to luncheon at the Windsor Hotel, Edinburgh.

**Signs of the Times.**—Owing to the enormous increase in business at the Acton Hill Electrical Works, Mr. Ronald Scott has been compelled to replace his gas engine by a steam engine developing 200 horse-power.

**The O. S. A.**—An ordinary general meeting of the Old Students' Association of the City and Guilds of London Institute, will be held at Finsbury Technical College, on Thursday, November 6th, 1890, at 8 p.m., when an address on "Industrialism" will be delivered by the President, Mr. W. B. Esson. This should be the means of attracting a large muster of members and friends.

**Patriotism and Telegraphy.**—French people have the reputation of being frivolous. Of all free and easy places Bougival, a pretty Parisian suburb, is one of the most celebrated, being a favourite resort to “canotiers” and “baigneurs” (and principally “baigneuses”). Still, Bougival is not behind in anything heroic. Last Saturday, 26th October, saw the annual commemoration of the deaths of three inhabitants, sacrificed in “l’Année Terrible,” victims of their devotion to their native country. One of these three braves, “Father Debergue,” as he was commonly known and called, was an uneducated person, aged seventy, who, not being able to take an active part in the defence of his invaded country, made it his business to interrupt telegraphic communications between the headquarters of the Prussian army at Versailles and an advanced post at Bougival. Many times did this patriotic old fellow cut the wire with his pruning knife without being detected, but at last he was caught in the very act. Taken before a court martial, he was condemned to death. The officer presiding, taking in kind consideration the advanced age of the culprit, offered to pardon him, provided that he swore never to do it again. Old Father Debergue proudly answered: “I am a Frenchman, and if I get free I will do it again.” A few minutes later he was shot along the wall.

**Edinburgh Exhibition.**—A petition was presented to the Court of Session on Tuesday last for the liquidation of the Edinburgh Exhibition. It is computed that the deficit will be about £40,000, the guarantee fund amounting to only £27,000.

**Institution of Electrical Engineers.**—The students will hold their next meeting on Friday, 7th November, when it is hoped that members will do their utmost to attend.

**Telephony in Parisian Suburbs.**—At the present time suburban districts are connected by telephone with Paris, and shortly six more suburbs will be also united to the Paris network. In addition to these, eight other communes are negotiating with the Administration in order to be telephonically connected with the city exchanges.

**Electric Tramway in Prague.**—It is proposed to lay down an electric railway in the exhibition which is to be held in Prague next year. The line will be about half a mile long, and will be of narrow gauge. It has not yet been decided whether to employ the accumulator or direct system of supply.

**Electric Light Fittings for Clubs.**—“The Cavalry” fittings, in Piccadilly, have throughout been designed and manufactured by Messrs. Faraday and Son, of Berners Street. The same firm has also designed the quaint brackets with sacristy lamps, in Venetian silver, which heralded the first night of “La Cigale,” under the new management at the Lyric Theatre.

**The McKinley Bill.**—This new tariff of the United States of America may be obtained from Simpkin, Marshall, Hamilton, Kent & Co., Limited, of Stationers’ Hall Court and Paternoster Row. It is “an Act to reduce the revenue and equalise duties on imports and for other purposes,” and it might be to the interest of anyone having dealings with America to invest 2s. in the purchase of the Act, or a copy may be seen at our office.

**Ship Lighting.**—The official trial trip of the ss. *Innaminka*, built by Messrs. Napier, Shanks and Bell, Yoker, to the order of Messrs. Elder, Smith & Co., London, on behalf of the Adelaide Steamship Company, Port Adelaide, Australia, took place on Saturday. The *Innaminka* has been handsomely fitted with all modern improvements, including electric light and electric bells.

**Paris Complaints against the Telephone Working.**—We take the following from *Le Soleil* of Tuesday:—“We draw the attention of the Higher Administration of Posts and Telegraphs to the bad working of the telephone lines in the interior of Paris. When complaints are made of the slowness of communications the *employés* reply that they can do no better on account of the insufficiency of the staff. If this be so, there is an urgent necessity to remedy a state of things which cannot fail, by its prolongation, to lead to the loss of a large number of subscriptions. Many subscribers only ask for one or two communications per day. They find that 400 francs per year is rather a large sum for losing daily an hour of their time.

**National Telephone Company Appointment.**—Mr. John D. Miller, district manager of the National Telephone Company, Limited, Dundee, has been appointed the company’s general manager for the division of Scotland north of the Forth, with offices at 13, Panmure Street, Dundee.

**Elmore Copper, &c.**—We have received a long letter, too late, however, for insertion in this issue, from Mr. W. Stepney Rawson, replying to our recent articles on Elmore Copper and Electro-deposition. It is evidently written in a moment of hot haste, and, says Mr. Rawson: “If I am incorrect in any of my statements you will publicly make the same known, but if not, it will only be left for your readers to conclude that you have made an unwarrantable attack upon a new industry without such knowledge of the matter as alone could justify you in doing so.” As our correspondent lays himself open to correction in almost every paragraph, we cannot reasonably refuse to gratify his desire to place his mistakes on record.

**Accumulator Explosions.**—The stupid conclusions at which the writer of that classic note on “Accumulator Explosions” arrived in the *Daily Telegraph*, and which we quoted last week, has already had a baneful effect, for we notice both daily and weekly papers of the “Society” kind commenting upon these little mishaps in the same way.

**General Electric Company.**—This company has sent us a copy of the latest edition (the fifth) of its electric light catalogue. Comparing it with the fourth edition, which was published only 18 months ago, we notice that its size, contents, and even weight are enormously increased, a fair indication, probably, of the extension which electric lighting has experienced in the period we have just passed through. The new edition of the catalogue contains every requisite for electric light installations of the most extensive character, both as regards central stations and private plant. The company considers it to be the most complete catalogue of electric plant which has been printed in any country, and has evidently spared no trouble and expense to make it perfect in every detail. Not only are the latest improvements and inventions included, but an endeavour has been made to reduce prices in accordance with standards ruling in the market at the present date. As a book of reference, we are told that the former issue of this catalogue has been much appreciated by engineers, architects and others who have had to make out estimates, and the present edition will certainly be found useful in estimating for plant and in ordering, both in England and abroad. It contains 126 pages and over 1,000 illustrations, and gives prices of, amongst others, the following articles:—Dynamoes, lamps, cables, switches, cut-outs, electricity and other meters, glassware, brass, copper, and iron fittings, casings, engines, motors, accumulators, &c.

**Lighting of Aldershot Camp.**—The authorities are considering the question of lighting the camp at Aldershot by electricity, and experiments will be shortly made.

**Electrical Engineering Corporation, Limited.**—Following the advent of a new addition to the board of this Corporation, notified in our City news, we learn that for the past nine months considerable extensions of the works at West Drayton have been progressing and are now complete. In the course of a week new machinery will be in operation, amongst the machine tools being some of the largest employed in the electrical industry.

**Hanley Electric Lighting.**—The corporation has decided to act on the recommendation of the committee to apply for powers to light the town by electricity.

**Glasgow Technical College.**—In Prof. Jamieson's evening classes alone in the Technical College about 150 "Electric Lighting" students have already been enrolled.

**The Latest Form of Advertising.**—One of the partners in a well-known firm of electric wire manufacturers on this side has just received a letter from America containing a faded flower, and couched in the following terms:—"Take back the flower thou gavest. I love you no longer; all my affection is now given to American Electrical Works, Providence, R.I., because they make such *beautiful* insulated electric wire.—I am no longer yours, MAUDE."

**The City and South London Railway.**—This electric railway is to be opened on Tuesday by His Royal Highness the Prince of Wales. We hope in our next issue to give full particulars of this, the first *electric railway* in England, which we trust may prove to be successful from all points of view.

**Alternating Current Lighting in Baltimore.**—The Brush Electric Company, of Baltimore, is increasing its alternating current plant, Westinghouse system, up to a capacity of 20,000 16-C.P. lamps, and when the additions and extensions are completed, there will be only two cities in the United States possessing larger systems of incandescent lighting, by alternating currents, than Baltimore, namely, Pittsburg, with 60,000 lights, and New York, with 50,000.

**Cremation Outdone.**—A young *savant*, Dr. Variot has just found out (?) that human bodies can be electrically mummified, and the Académie des Sciences is very shortly to be treated to exhibitions of the metalised bodies of newly born children. We believe that similar schemes were years ago exploded. Touching upon the subject, Dr. Variot claims that, by his (?) process, he can perpetuate, in the shape of authentic figures, *i.e.*, the very bodies (metalised) of the subjects which it is desired to so hand down to posterity by merely submitting them to the process of galvanisation. We are afraid that popular sentiment would be greatly against the adoption of such a scheme, as in the majority of cases the impression of features after death would give no true indication of what they were in life.

**The Progress of Civilisation.**—We are indebted to the *Referee* for the following information concerning the backward state of this country so far as scientific matters are concerned:—"Switzerland is far ahead of England so far as the application of scientific ideas and discoveries is concerned. In the smallest town in Switzerland you have the electric tram, the electric light, and the public telephone. Even up the valleys, in villages miles from a railway station, you can go into a tobacconist's shop, buy a halfpenny cigar, and use his telephone for nothing, and the old gentleman who sells baked chestnuts at the corner of an alley in the poorest quarter of a tenth-rate town has the electric light laid on over his stall; and yet in London, until the Swiss brothers took the matter in hand, the electric light was looked upon as something only fit for a Baron Rothschild or a Duke of Westminster to play with in his private house." Would it not be better that our sporting contemporary should confine itself to matters which its editors are able to understand?

**The Electric Light in Madrid.**—On the evening of October 19th, the inauguration of the new works of the Electricity Supply Company, was made the occasion of a banquet at which were present many influential persons. The works are situated close to the railway station of Las Delicias. The principal portions of the building are occupied by the machine and boiler rooms, each 132 feet long by 60 wide, the first containing 6 engines, exciters and dynamos, the second, 6 large boilers. The lighting is calculated to be sufficient for 24,000 incandescence lamps. In addition to the usual offices, test-rooms, workshops, &c., some space is devoted to an exhibition, intended to be permanent, of a complete system of house lighting, showing not only the technical or scientific apparatus in use, but also a great variety of what may be termed the more ornamental portions of an installation.

**Traction in Vienna.**—The Vienna Tramway Company has just submitted to the Minister of Commerce a project for the transformations of the present tramway system in that city. The scheme comprises the separation of the Ring traffic from the radial traffic, the working by electricity of the Ringstrasse tramway service, and the construction of a narrow gauge underground electric railway, which would traverse the town in two directions, namely, from the Schottenring to the Stubenring, and from the Burgring to the Ferdinandsbrücke and Aspernbrücke. The larger portion of this railway would comprise a tunnel in which a single track, 1 metre gauge, would be laid. Stations with double lines would be built at distances of from 325 to 540 yards, so that a three minutes' service in either direction could be effected. The tunnel would be lighted electrically, and it would be possible for a passenger to travel across the town in five minutes. The tramway company are prepared to construct this underground line as an integral part of the tramway system. The first steps which would be taken would be the introduction of electric traction on the Ringstrasse tramway by means of an underground conductor system.

#### NEW COMPANIES REGISTERED.

**D. Glasgow Huxley and Company, Limited.**—Capital, £1,000 in £10 shares. Objects: To trade as chemists and druggists, herbalists, and oil and colourmen, and to manufacture and deal in surgical, electrical, photographic, and other scientific instruments and requisites. Signatories (with 1 share each): D. Glasgow Huxley, Hy. D. Huxley, Isabella Huxley, Eliza Huxley, and Mary Howison, all of Sheffield; H. Barrow and Walter Balby (engineers), of Attercliffe. Registered, without special articles of association, by R. J. S. Douglas, 4, Æolian Villas, Muswell Hill, N. Registered office, 178, Cemetery Road, Sheffield.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Kidderminster Electric Light and Power Supply, Limited.**—The statutory return of this company, made up to the 16th inst., was filed on the 20th inst. The nominal capital is £1,000, divided into 900 ordinary and 100 founders' shares of £1 each. Seven founders' shares are taken up, and upon these no call has yet been made. Registered office, Westminster Chambers, 5, Victoria Street, S.W.

**East Coast Electric Light and Power Supply, Limited.**—The statutory return of this company, made up to the 16th inst., was filed on the 20th inst. The nominal capital is £1,000, divided into 100 founders' and 900 ordinary shares of £1 each. Only seven founders' shares are at present taken up, and upon these no call has yet been made. Registered office, 5, Victoria Street, S.W.

**Barry and Cardiff Electric Light and Power Supply, Limited.**—The statutory return of this company, made up to the 16th inst., was filed on the 20th inst. The nominal capital is £1,000 in £1 shares, but seven founders' shares are all at present taken up; upon these no call has been made. Registered office, 5, Victoria Street, S.W.

**Devonshire Electric Light and Power Supply, Limited.**—The statutory return of this company, made up to the 16th inst., was filed on the 20th inst. The nominal capital is £1,000 in £1 shares, but only seven are at present taken up, and upon these no call has been made. Registered office, 5, Victoria Street, S.W.

**Camberwell and Islington Electric Light and Power Supply, Limited.**—The statutory return of this company, made up to the 16th inst., was filed on the 20th inst. The nominal capital is £1,000 divided into 900 ordinary and 100 founders' shares of £1 each. Seven founders' shares are taken up, but no call has been made thereupon. Registered office, 5, Victoria Street, S.W.

**Stamford Hill, Tottenham and Edmonton Electric Light and Power Company, Limited.**—The statutory return of this company, made up to the 16th inst., was filed on the 20th inst. The nominal capital is £1,000 divided into 900 ordinary and 100 founders' shares of £1 each. Seven of the latter are taken up, but no call has been made thereon. Registered office, 5, Victoria Street, S.W.

**Provincial Electric Light and Power Supply, Limited.**—The statutory return of this company, made up to the 16th inst., was filed on the 20th inst. The nominal capital is £1,000 divided into 900 ordinary and 100 founders' shares of £1 each. Seven of the founders' shares are taken up, but no call has been made thereon. Registered office, 5, Victoria Street, S.W.

**Vaughan Sherrin Electrical Engineering Company, Limited.**—At a meeting of the subscribers to this company, held at 48, Eagle Wharf Road, Islington, on the 15th inst., it was proposed and carried that the number of directors shall be four, and that the first shall be John Ramsay L'Amy, J.P., D.L., of 107, Cromwell Road, S.W.; Lieut.-Colonel Elphinstone Dalrymple, of 6, Gledstone Road, West Kensington; Herbert Woodgate, of 123, Pall Mall; and J. Vaughan Sherrin, of 3, Codrington Road, Hampstead.

**Norwich Electricity Company, Limited.**—The registered office of this company is now situated at 1, Old Bank of England Chambers, Queen Street, Norwich.

**Electro-Chemical Syndicate, Limited.**—The registered office of this company is situated at Monument Buildings, E.C.

**Leeds and London Electrical Engineering Company, Limited.**—The registered office of this company is situate at 117, Bishopsgate Street Within.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Monte Video Telephone Company, Limited.

THE following report will be presented to the shareholders at the annual general meeting, to be held at the offices of the company, at 12 noon to-day. The statement of accounts for the year ending 31st July last, shows a gross profit of £10,301 5s. 9d., after providing for all working expenses in Monte Video and London. Off this sum there has been written £114 14s. 8d. for preliminary expenses, and £19 10s. 10d. for depreciation of furniture, leaving a balance of £10,167 0s. 3d. To this must be added the balance from last year, £325 8s. 5d., making a total now to be dealt with of £10,492 8s. 8d.

The directors recommend that of this amount the full dividend of 6 per cent. on the preference shares amounting to £8,308 7s. 2d. be declared, that £1,000 be added to the depreciation fund, and that the balance £1,184 1s. 6d. be carried forward. An interim dividend on the preference shares was paid in March last.

During the year the sum of £5,600 6s. 7d. has been expended on

capital account, chiefly in consequence of the completion of the fixture of the multiple switchboard, cables and lines for new subscribers.

The directors regret that the results for the past year have not come up to their expectations, but bearing in mind the severe commercial depression which for a considerable portion of that year has prevailed in Monte Video and which has caused very many subscribers to curtail their expenses by relinquishing their subscriptions to the telephone exchanges, they cannot but deem it satisfactory to have maintained the profit at about £10,000. For these reasons it has not been deemed advisable to recommend any dividend on the ordinary shares. It is gratifying, however, to report that the latest advices from the manager are to the effect that a large number of subscribers who had left for a variety of reasons, have returned to the company.

In accordance with the articles of association, Mr. Peters retires from the board, but, being eligible, offers himself for re-election.

The auditors, Messrs. Gérard Van de Linde & Son, also retire, but offer themselves for re-election.

### The Metropolitan Electric Supply Company, Limited.

THE following is the report of the directors issued on Wednesday to the shareholders, and to be presented to the third ordinary general meeting next week:—

"1. Under the Electric Lighting Act it has been provided that the accounts of statutory supply companies shall be made up to the 31st December in each year, and that these accounts shall be presented to the Board of Trade not later than the 25th March in the year following.

"2. It will be remembered that last year the accounts were made up to the 30th September; in order, therefore, to comply with the above-mentioned statutory requirements, it is necessary to alter the period of the company's financial year to the end of December, and the date of the annual general meeting to the beginning of next year. The accounts for the 15 months ending the 31st December next will therefore be submitted to the meeting to be held early in 1891.

"3. The present meeting has been convened in accordance with article 71 of the company's articles of association, which provides that an ordinary meeting shall be held annually.

"4. The directors are pleased to have the opportunity of informing the shareholders that the company is making steady and substantial progress in its works, and that what promises to be a large and remunerative business is being built up.

"5. During the 14 months which have elapsed since the company obtained Parliamentary powers, upwards of 40 miles of electric light mains have been laid in pipes under the streets of the principal thoroughfares of the company's districts.

"6. Current is being supplied from four central stations, two of which, viz., Whitehall and Sardinia Street, are fully equipped, while the other two, viz., Rathbone Place and Manchester Square, are on the eve of completion.

"7. The company's area of supply has been enlarged by the addition of the important and valuable district of Paddington. The directors are giving careful consideration to the best means of supplying current in this district, and an advantageous site on which to erect a central station has already been acquired on favourable terms.

"8. While it is impossible, until the accounts have been made up and audited, to review the company's financial position in detail, the directors are of opinion that the prospects of the company are such as to warrant them in looking forward to a satisfactory dividend being earned during the ensuing year.

"9. In accordance with the articles of association, three of the directors, viz., Sir James Anderson, Mr. J. Spencer Balfour, M.P., and Sir George Elliott, Bart., M.P., retire by rotation, and, being eligible, offer themselves for re-election.

"10. The auditors, Messrs. Deloitte, Dever, Griffiths & Co. retire, and offer themselves for re-election.

### The Indo-European Telegraph Company, Limited.—

The board of this company has declared an interim dividend for the half-year ended the 30th June last, at the rate of 5 per cent. per annum.

**Electrical Engineering Corporation, Limited.**—Mr. Carl Von Buch, of Messrs. Foote and Von Buch, electrical engineers, 11, Queen Victoria Street, E.C., has joined the board.

**Messrs. Ruston, Procter & Co.**—This company has declared an interim dividend of 5s. per share.

## TRAFFIC RECEIPTS

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 24th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,742.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending October 24th were £4,834.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (October 23.)	Closing Quotation. (October 30.)	Business done during week ending October 30, 1890.	
					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	99 — 102	99 — 102		
1,549,160	Anglo-American Telegraph, Limited	Stock	49 — 50 xd	48½ — 49½	49½	48½
2,725,420	Do. do. 6 p. c. Preferred	Stock	85 — 86 xd	84½ — 85½	85½	85½
2,725,420	Do. do. Deferred	Stock	13 — 13½	13 — 13½	13½	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 12½	11½ — 11½	12½	11½ xd
84,500	Do. do. 5 p. c. Bonds	100	100 — 102	100 — 102		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	103 — 107	105½	105
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 1½	1½ — 1½		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2		
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104		
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	½ — ½	½ — ½ xd	½	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,000	Cuba Telegraph, Limited	10	11½ — 12	11½ — 12		
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4½ xd	3½ — 4½		
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½ xd	8½ — 9½	8½	8½
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½ xd	10½	...
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½ xd	13½ — 14	14½	13½
70,000	Do. do. 6 p. c. Preference	10	14½ — 15½ xd	14½ — 15½	15	14½
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	107	...
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	104 — 107	103 — 106 xd	107	105
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14½ — 14½ xd	14 — 14½	14½	14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102		
91,800	{ Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326	100	102 — 105	102 — 105	10½	...
325,200	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400	100	102 — 105	102 — 105		
145,300	{ Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 — 104	101 — 104	102½	...
198,200	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 — 104	101 — 104		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8	7½ — 8	7½	7½
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5½	5 — 5½	6½	4½
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid)	2	1½ — 2½	1½ — 1½	1½	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,000 ... (£3 only paid)	5	2½ — 3	3½ — 4		
180,227	Globe Telegraph and Trust, Limited	10	9 — 8½	8½ — 9½	9	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 14½	14½ — 15	14½	...
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	15½	...
15,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104		
230,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107		
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		
41,609	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18½ — 19½	18½	...
200,000	Do. do. do. 4½ p. c. Deb., 1896	100	100 — 102	100 — 102 xd		
17,000	Indo-European Telegraph, Limited	25	36 — 38	35 — 37 xd		
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6½ — 7		
100,000	Do. do. do. 6 p. c. Debentures	100	105 — 108	105 — 108		
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5 — 5½	5½ — 6	5½	5½
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4½ — 4½	4½ — 4½	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½		
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½ — 10½	9½ — 10½		
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8 — 8	8 — 8		
9,000	Reuter's, Limited	8	8½ — 8½ xd	8½ — 8½		
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	8 — ...	8 — 8		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3 xd		
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117		
78,949	Swan United Electric Light, Limited	5	5½ — 5½	5 — 5½	5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	44½	44
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4		
146,128	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94		
3,200	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½ — 9½	8½ — 9½		
290,900	Do. do. do. 5 p. c. Debentures	100	98 — 101	98 — 101	100	99½
30,000	West Coast of America Telegraph, Limited	10	4½ — 5	4 — 5		
150,000	Do. do. do. 8 p. c. Debs. repay. 1902	100	102 — 107	102 — 107	103½	...
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11½	11½
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 7	6½	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4½ — 5	4½ — 5		
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106		
250,000	Do. do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106		
88,321	West India and Panama Telegraph, Limited	10	3 — 3½	3 — 3½	3½	3½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 12	11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	14 — 15	14 — 15	14½	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	122 — 127	122 — 127		
175,100	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 3	2½ — 3		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 1½—1½.—House-to-House Company (£5 paid), 4½—5½.—International Okonite, Ordinary of £10 (£7 paid), 6½—7½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/-—13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2½—3½.—Preference, 4½—4½.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.  
(Continued from page 505.)

There is a paradoxical experiment which we will try next week, that illustrates an important principle. If you take a tubular electro-magnet and put little pieces of iron into the ends of the iron tube that serves as core, and then magnetise it, the little pieces of iron will try to push themselves out. There is always a tendency to try and increase the completeness of the magnetic circuit; the circuit tends to re-arrange itself so as to make it easier for the magnetic lines to go round.

Here is another paradoxical experiment. I have here a bar electro-magnet, which we will connect to the wires that bring the exciting current. In front of it, and at a distance from one end of the iron core, is a small compass needle with a feather attached to it as a visible indicator, so that when we turn on the current the electro-magnet will act on the needle, and you will see the feather turn round. It is acting there at a certain distance. The magnetising force is mainly spent not to drive magnetism round a circuit of iron, but to force it through the air, flowing from one end of the iron core out into the air, passing by the compass needle, and streaming round again, invisible, into the other end of the iron core. It ought to increase the flow if we can in any way aid the magnetic lines to flow through the air. How can I aid this flow? By putting on something at the other end to help the magnetic lines to get back home. Here is a flat piece of iron. Putting it on here at the hinder end of the core ought to help the flow of magnetic lines. You see that the feather makes a rather larger excursion. Taking away the piece of iron diminishes the effect. So also in experiments on tractive power, it can be proved that the adding of a mass of iron at the far end of a straight electro-magnet greatly increases the pulling power at the end that you are working with; while, on the other hand, putting the same piece of iron on the front end as a pole-piece greatly diminishes the pull. Here, clamped to the table, is a bar electro-magnet excited by the current; and here is a small piece of iron attached to a spring balance, by means of which I can measure the pull required to detach it. With the current which I am employing, the pull is about 2½ lbs. I now place upon the front end of the core this block of wrought iron; it is itself strongly held on; but the pull which it itself exerts on the small piece of iron is small. Less than half a pound suffices to detach it. I now remove the iron block from the front end of the core, and place it upon the hinder end. And now I find that the force required to detach the small piece of iron from the front end is about 3½ lbs., instead of 2½ lbs. The front end exerts a bigger pull when there is a mass of iron attached to the hinder end. Why? The whole iron core, including its front end, becomes more highly magnetised, because there is now a better way for the magnetic lines to emerge at the other end and come round to this. In short, we have diminished

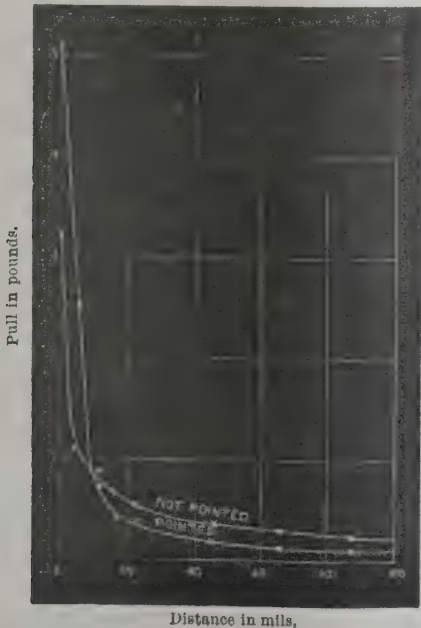


FIG. 35.—CONTRASTED EFFECT OF FLAT AND POINTED POLES.

the magnetic reluctance of the air part of the magnetic circuit, and the flow of magnetic lines in the whole magnetic circuit is thereby improved. So it was also when the mass of iron was placed across the front end of the core; but the magnetic lines streamed away backwards from its edges; and few were left in

front to act upon the small bit of iron. So the law of magnetic circuit action explains this anomalous behaviour. Facts like these have been well known for a long time to those who have studied electro-magnets. In Sturgeon's book there is a remark that bar magnets pull better if they are armed with a mass of iron at the distant end, though Sturgeon did not see what we now know to be the explanation of it. The device of fastening a mass of iron to one end of an electro-magnet in order to increase the magnetic power of the other end was patented by Siemens in 1862.

We are now in a position to understand the bearing of some curious and important researches made about forty years ago by Dr. Julius Dub, which, like a great many other good things, lie buried in the back volumes of Poggendorff's *Annalen*. Some account of them is also given in Dr. Dub's now obsolete book, entitled *Elektromagnetismus*.

The first of Dub's experiments to which I will refer relates to the difference in behaviour between electro-magnets with flat and those with pointed pole ends. He formed two cylindrical cores, each six inches long, from the same rod of soft iron, one inch in diameter. Either of these could be slipped into an appropriate magnetising coil. One of them had the end left flat, the other had its end pointed, or, rather, it was coned down until the flat end was left only ¼ inch in diameter, possessing therefore only one-fourth of the amount of contact surface which the other core possessed. As an armature there was used another piece of the same soft iron rod, 12 inches long. The pull of the electro-magnet on the armature at different distances was carefully measured, with the following results:—

Distance apart in inches.	Pull on flat pole (lbs.).	Pull on pointed pole (lbs.).
0	3.3	5.2
0.0055	1.1	1.8
0.0110	0.9	0.75
0.0165	0.71	0.50
0.022	0.60	0.42
0.044	0.38	0.20
0.088	0.19	0.09

These results are plotted out in the curves in fig. 35. It will be seen that in contact, and at very short distances, the reduced pole gave the greater pull. At about ten mils distance there was equality, but at all distances greater than ten mils the flat pole had the advantage. At small distances the concentration of magnetic lines gave, in accordance with the law of traction, the advantage to the reduced pole. But this advantage was, at the greater distances, more than outweighed by the fact that with the greater widths of air-gap the use of the pole with larger face reduced the magnetic reluctance of the gap and promoted a larger flow of magnetic lines into the end of the armature.

Dub's next experiments relate to the employment of polar extensions or pole-pieces attached to the core. These experiments are so curious, so unexpected, unless you know the reasons why, that I invite your especial attention to them. If an engineer had to make a firm joint between two pieces of metal, and he feared that a mere attachment of one to the other was not adequately strong, his first and most natural impulse is to enlarge the parts that come together—to give one as it were a broader footing against the other. And that is precisely what an engineer, if uninstructed in the true principles of magnetism, would do in order to make an electromagnet stick more tightly on to its armature. He would enlarge the ends of one or both. He would add pole pieces to give the armature a better foothold. Nothing, as you will see, could be more disastrous. Dub employed in these experiments a straight electro-magnet having a cylindrical soft iron core, 1 inch in diameter, 12 inches long; and as armature a piece of the same iron, 6 inches long. Both were flat ended. Then six pieces of soft iron were prepared of various sizes, to serve as pole pieces. They could be screwed on at will either to the end of the magnet core or to that of the armature. To distinguish them we will call them by the letters A, B, C, &c. Their dimensions were as follows, the inches being presumably Bavarian inches:—

Piece.	Diameter.	Length.
	inches.	inches.
A	2	1
B	1½	1½
C	1⅓	2
D	2	½
E	1½	1
F	1	2

Of the results obtained with these pieces we will select eight. They are those illustrated by the eight collected sketches in fig. 36. The pull required to detach was measured, also the attraction exerted at a certain distance apart. It will be noted that, in every case, putting on a pole piece to the end of the magnet diminished both the pull in contact and the attraction at a distance

\* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

it simply promoted leakage and dissipation of the magnetic lines. The worst case of all was that in which there were pole-pieces both on the magnet and on the armature. In the last three cases the pull was increased, but here the enlarged piece was attached to the armature, so that it helped those magnetic lines which came up into it to flow back laterally to the bottom end of the electro-magnet, while thus reducing the magnetic reluctance of the return path through the air, and so increasing the total number of magnetic lines, did not spread unduly those that issued up from the end of the core.

Experiment.	On magnet.	On armature.	Traction.	Attraction.
I.	none	none	48	22
II.	D	none	30	10
III.	E	none	32	11.5
IV.	C	none	35	13.5
V.	D	A	20	7.5
VI.	none	B	50	25
VII.	none	D	43	25
VIII.	none	C	50	18

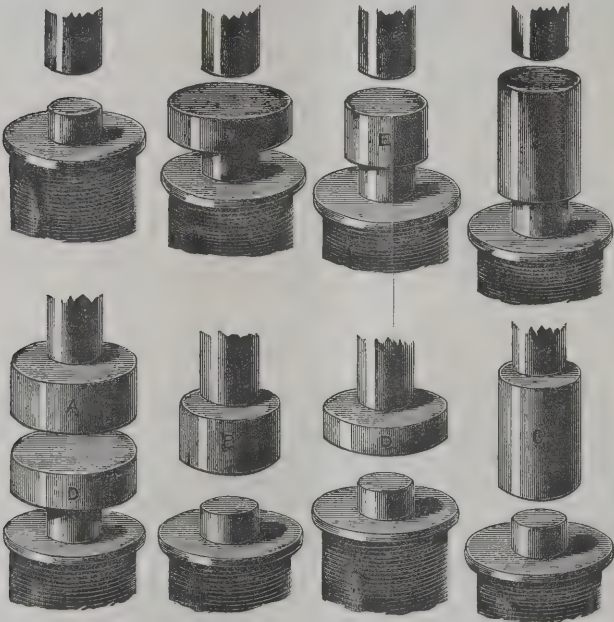


FIG. 36.—DUB'S EXPERIMENTS WITH POLE-PIECES.

The next of Dub's results relate to the effect of adding these pole-pieces to an electro-magnet 12 inches long, which was being employed, broadside-on, to deflect a distant compass needle (fig. 37).



FIG. 37.—DUB'S DEFLECTION EXPERIMENT.

Pole-piece used.	Deflection (degrees).
none ... ..	34.5
A ... ..	42
B ... ..	41.5
C ... ..	40.5
D ... ..	41
E ... ..	39
F ... ..	38

In another set of experiments of the same order a permanent magnet of steel, having poles, *n*, *s*, was slung horizontally by a bifilar suspension, to give it a strong tendency to set in a particular direction. At a short distance laterally was fixed the same bar electro-magnet, and the same pole-pieces were again employed. The results of attaching the pole-pieces at the rear end are not very conclusive; they slightly increased the deflection. But in the absence of information as to the distance between the steel magnet and the electro-magnet, it is difficult to assign proper values to all the causes at work. The results were :—

Pole-piece used.	Deflection (degrees).
none ... ..	8.5
A ... ..	9.2
B ... ..	9.5
C ... ..	10
D ... ..	8.8

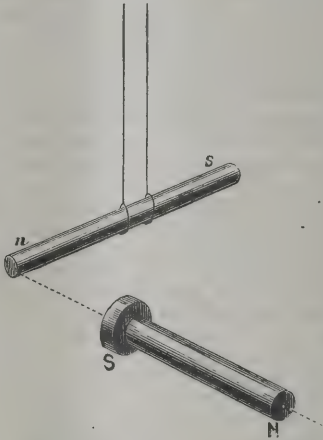


FIG. 38.—DEFLECTING A STEEL MAGNET HAVING BIFILAR SUSPENSION, POLE-PIECE ON NEAR END.

When, however, the pole-pieces were attached to the distant end of the electro-magnet, where their effect would undoubtedly be to promote the leakage of magnetic lines into the air at the front end without much affecting the distribution of those lines in the space in front of the pole, the action was more marked.

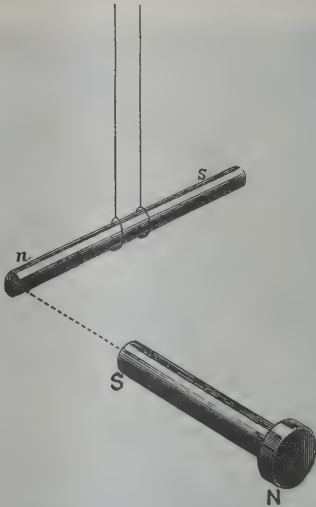


FIG. 39.—DEFLECTING STEEL MAGNET, POLE-PIECE ON DISTANT END.

Pole-piece used.	Deflection (degrees).
None ... ..	8.5
A ... ..	10.0
B ... ..	10.3
C ... ..	10.3
F ... ..	10.1

Still confining ourselves to straight electro-magnets, I now invite your attention to some experiments made in 1862 by the late Count Du Moncel as to the effect of adding a polar expansion to the iron core. He used as his core a small iron tube, the end of

which he could close up with an iron plug, and around which he placed an iron ring which fitted closely on to the pole. He used a special lever arrangement to measure the attraction exercised upon an armature distant in all cases one millimetre from the pole. The results were as follows :—

	Without ring on pole.	With ring on pole.
Tubular core alone ... ..	11	10
ditto with iron plug ... ..	17	14
Core provided with mass of iron at distant end	27	25
ditto ditto with iron plug ...	38	33

After hunting up these researches, it was extremely interesting to find that so important a fact had not escaped the observant eye of the original inventor of the electro-magnet. In Sturgeon's "Experimental Researches" (p. 113) there is a footnote, written apparently about the year 1832, which runs as follows—

"An electro-magnet of the above description, weighing three ounces, and furnished with one coil of wire, supported 14 lbs. The poles were afterwards made to expose a larger surface by welding to each end of the cylindric bar a square piece of good soft iron; with this alteration only the lifting power was reduced to about 5 lbs., although the magnet was annealed as much as possible."

We saw that this straight electro-magnet, whether used broad-side-on or end-on, could act on the compass needle at some distance from it, and deflect it. In those experiments there was no return-path for the magnetic lines that flowed through the iron core save that afforded by the surrounding air. The lines flowed round in wide-sweeping curves from one end to the other, as in fig. 26; the magnetic field being quite extensive. Now, what will happen if we provide a return path? Suppose I surround the electro-magnet with an iron tube of the same length as itself, the lines will flow along in one direction through the core, and will find an easy path back along the outside of the coil. Will the magnet thus jacketed pull more powerfully or less on that little suspended magnet? I should expect it to pull less powerfully, for if the magnetic lines have a good return path here through the iron tube, why should they force themselves in such a quantity to a distance through air in order to get home? No, they will naturally return short back from the end of the core into the tubular iron jacket. That is to say, the action at a distance ought to be diminished by putting on that iron tube outside. Here is the experiment set up. And you see that when I turn on the current my indicating needle is scarcely affected at all. The iron jacket causes that magnet to have much less action at a distance. Yet I have known people who actually proposed to use jacketed magnets of this sort in telegraph instruments, and in electric motors, on the ground that they give a bigger pull. You have seen that they produce less action at a distance across air, but there yet remains the question whether they give a bigger pull in contact? Yes, undoubtedly they do; because everything that is helping the magnetism to get round to the other end increases the goodness of the magnetic circuit, and therefore increases the total magnetic flux.

We will try this experiment upon another piece of apparatus, one which has been used for some years at the Finsbury Technical College. It consists of a straight electro-magnet set upright in a base-board, over which is erected a light gallows of wood. Across the frame of the gallows goes a winch, on the axle of which is a small pulley with a cord knotted to it. To the lower end of the cord is hung a common spring balance, from the hook of which depends a small horizontal disc of iron to act as an armature. By means of the winch I lower this disc down to the top of the electro-magnet. The current is turned on; the disc is attracted. On winding up the winch I increase the upward pull until the disc is detached. See, it required about 9 lbs. to pull it off. I now slip over the electro-magnet, without in any way attaching it, this loose jacket of iron—a tube, the upper end of which stands flush with the upper polar surface. Once more I lower the disc, and this time it attaches itself at its middle to the central pole, and at its edges to the tube. What force will now be required to detach it? The tube weighs about ½ lb., and it is not fixed at the bottom. Will 9½ lbs. suffice to lift the disc? By no means. My balance only measures up to 24 lbs., and even that pull will not suffice to detach the disc. I know of one case where the pull of the straight core was increased 16-fold by the mere addition of a good return-path of iron to complete the magnetic circuit. It is curious how often the use of a tubular jacket to an electro-magnet has been re-invented. It dates back to about 1850, and has been variously claimed for Romershausen, for Guillemin, and for Fabre. It is described in Davis's "Magnetism," published in Boston in 1855. About 16 years ago Mr. Faulkner, of Manchester, revived it, under the name of the *Altanda* electro-magnet. A discussion upon jacketed electro-magnets took place in 1876, at the Society of Telegraph Engineers; and in the same year, Prof. Graham Bell used the same form of electro-magnet in the receiver of the telephone which he exhibited at the Centennial Exhibition. But the jacketed form is not good for anything except increasing the tractive power. Jacketing an electro-magnet which already possesses a return circuit of iron is an absurdity. For this reason, the proposal made by one inventor to put iron tubes outside the coils of a horseshoe electro-magnet is one to be avoided.

We will take another paradox, which equally can be explained by the principle of the magnetic circuit. Suppose you take an iron tube as an interior core; suppose you cut a little piece off the end of it; a mere ring of the same size. Take that little piece and lay it down on the end. It will be struck with a certain amount of pull. It will pull off easily. Take that same round piece of iron, put it on edgewise, where it only touches one point of the circumference, and it will stick on a good deal tighter, because it is there in a position to increase the magnetic flow of the magnetic lines. By concentrating the flow of magnetic lines over a small surface of contact increases B at that point, and B<sup>2</sup>, integrated over the lesser area of the contact, gives a total bigger pull than is the case when the edge is touched all round against the edge of the tube.

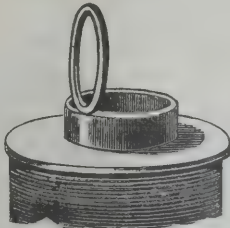


FIG. 40.—EXPERIMENT WITH TUBULAR CORE AND IRON RING.

Here is a still more curious experiment. I use a cylindrical electro-magnet set up on end, the core of which has at the top a flat circular polar surface about two inches in diameter. I now take a round disc of thin iron—ferrotype or tin-plate will answer quite well—which is a little smaller than the polar face. What will happen when this disc is laid down flat and centrally on the polar face? Of course you will say that it will stick tightly on. If it does so, the magnetic lines which come in through its under surface will pass through it and come out on its upper surface in large quantities. It is clear that they cannot all, or even any considerable proportion of them, emerge sideways through the edges of the thin disc, for there is not substance enough in the disc to carry so many magnetic lines. As a matter of fact, the magnetic lines do come through the disc, and emerge on its upper surface, making indeed a magnetic field over its upper surface that is nearly as intense as the magnetic field beneath its under surface. If the two magnetic fields were exactly of equal strength, the disc ought not to be attracted either way. Well, what is the fact? The fact, as you see now that the current has been turned on, is that the disc absolutely refuses to lie down on the top of the pole. If I hold it down with my finger, it actually bends itself up, and requires force to keep it down. I lift my finger and over it flies. It will go anywhere in its effort to better the magnetic circuit rather than lie flat on the top of the pole.

Next I invite your attention to some experiments, originally due to Von Kolke, published in the *Annalen* forty years ago, respecting the distribution of the magnetic lines where they emerge from the polar surface of an electro-magnet. I cannot enumerate them all, but will merely illustrate them by a single example. Here is a straight electro-magnet with a cylindrical, flat-ended core (fig. 41). In what way will the magnetic lines be distributed over at the end? Fig. 41 illustrates roughly the way in which, when

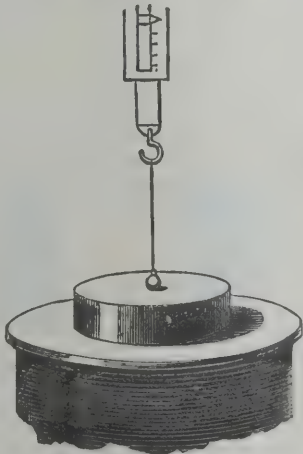


FIG. 41.—EXPLORING POLAR DISTRIBUTION WITH SMALL IRON BALL.

there is no return-path of iron, the magnetic lines leak through the air. The main leakage is through the ends, though there is some at the sides also. Now the question of the end-distribution we shall try by using a small bullet of iron, which will be placed at different points from the middle to the edge, a spring balance being employed to measure the force required to detach it. The pull at the edge is much stronger than at the middle, at least four or five times as great. There is a regular increase of pull from the middle to the edge. The magnetic lines, in trying to complete their own circuit, flow most numerous in that direction where

they can go furthest through iron on their journey. They leak out more strongly at all edges and corners of a polar surface. They do not flow out so strongly at the middle of the end surface, otherwise they would have to go through a larger air circuit to get back home. The iron is consequently more saturated round the edge than at the middle; therefore, with a very small magnetising force, there is a great disproportion between pull at the middle and that at the edges. With a very large magnetising force you do not get the same disproportion, because if the edge is already far saturated you cannot by applying higher magnetising power increase its magnetisation much, but you can still force more lines through the middle. The consequence is, if you plot out the results of a succession of experiments of the pull at different

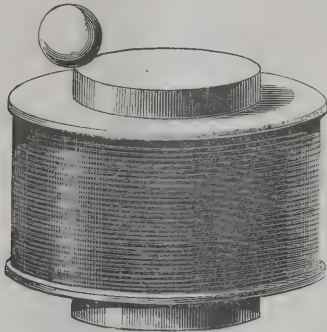


FIG. 42.—IRON BALL ATTRACTED TO EDGE OF POLAR FACE.

points, the curves obtained are, with larger magnetising forces more nearly straight than are those obtained with small magnetising forces. I have known cases where the pull at the edge was six or seven times as great as in the middle with a small magnetising power, but with larger power not more than two or three times as great, although, of course the pull all over was greater. You can easily observe this distribution by merely putting a polished iron ball upon the end of the electro-magnet, as in fig. 42. The ball at once rolls to the edge and will not stay at the middle. If I take a larger two-pole electro-magnet (like fig. 11) what will the case now be? Clearly the shortest path of the magnetic lines through the air is the path just across from the edge of one polar surface to the edge of the other between the poles. The lines are most dense in the region where they arch over in as short an arch as possible, and they will be less dense along the longer paths, which arch more widely over. Therefore, as there is a greater tendency to leak from the inner edge of one pole to the inner edge of the other, and less tendency to leak from the outer edge of one to the outer edge of the other, the biggest pull ought to be on the inner edges of the pole. We will now try it. On putting the iron ball anywhere on the pole it immediately rolls until it stands perpendicularly over the inner edge.

The magnetic behaviour of little iron balls is very curious. A small round piece of iron does not tend to move at all in the most powerful magnetic field if that magnetic field is uniform. All that a small ball of iron tends to do is to move from a place where the magnetic field is weak to a place where the magnetic field is strong. Upon that fact depends the construction of several important instruments, and also certain pieces of electro-magnetic mechanism.

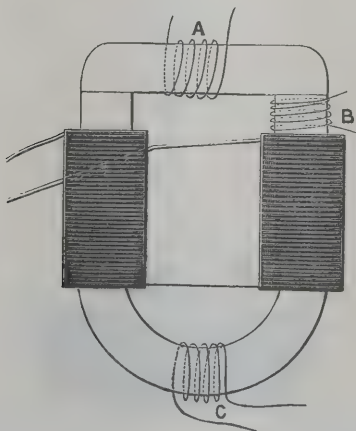


FIG. 43.—EXPERIMENT ON LEAKAGE OF ELECTRO-MAGNET.

In order to study this question of leakage, and the relation of leakage to pull, still more incisively, I devised some time ago a small experiment with which a group of my students at the Technical College have been diligently experimenting. Here (Fig. 43) is a horseshoe electromagnet. The core is of soft wrought iron, wound with a known number of turns of wire. It is provided with an armature. We have also wound on three little exploring coils, each consisting of five turns of wire only, one, c, right down at the bottom, on the bend; another, b, right round the pole, close up to the armature; and a third, a, around the

middle of the armature. The object of these is to ascertain how much of the magnetism which was created in the core by magnetising power of these coils ever got into the armature. If the armature is at a considerable distance away, there is naturally a great deal of leakage. The coil, c, around the bend at the bottom is to catch all the magnetic lines that go through the iron; the coil, b, at the poles is to catch all that have not leaked outside before the magnetism has crossed the joint; while the coil, a, right around the middle of the armature, catches all the lines that actually pass into the armature and pull at it. We measure by means of the ballistic galvanometer and these three exploring coils how much magnetism gets into the armature at different distances, and are able thus to determine the leakage and compare these amounts with the calculations made, and with the attractions at different distances. The amount of magnetism that gets into the armature does not go by a law of inverse squares, I can assure you, but by quite other laws. It goes by laws which can only be expressed as particular cases of the law of the magnetic circuit. The most important element of the calculations, indeed, in many cases is the amount of percentage of leakage that must be allowed for. Of the magnitude of this matter you will get a very good idea by the result of these experiments following.

The iron core is 13 millimetres in diameter, and the coil consists of 178 turns. The first swing of the galvanometer when the current was suddenly turned on or off measures the number of magnetic lines thereby sent through, or withdrawn from, the exploring coil that is at the time joined to the galvanometer. The currents used varied from 0·7 of an ampère to 5·7 ampères. Six sets of experiments were made with the armature at different distances. The numerical results are given below:—

I.—WITH WEAK CURRENT (0·7 AMPERES.)

	A	B	C
In contact ... ..	12,506	13,870	14,190
Armature distance. { 1 mm. ... ..	1,552	2,163	3,786
2 mm. ... ..	1,149	1,487	2,839
5 mm. ... ..	1,014	1,081	2,028
10 mm. ... ..	676	1,014	1,690
Removed ... ..	...	675	1,352

II.—STRONGER CURRENT (1·7 AMPERES.)

	A	B	C
In contact ... ..	18,240	19,590	20,283
Armature distance. { 1 mm. ... ..	2,570	3,381	5,408
2 mm. ... ..	2,366	2,839	5,073
5 mm. ... ..	1,352	2,299	5,949
10 mm. ... ..	811	1,352	3,381
Removed ... ..	...	1,38	3,041

III.—STILL STRONGER CURRENT (3·7 AMPERES.)

	A	B	C
In contact ... ..	20,940	22,280	22,960
Armature distance. { 1 mm. ... ..	5,610	7,568	11,831
2 mm. ... ..	4,597	6,722	9,802
5 mm. ... ..	2,569	3,245	7,436
10 mm. ... ..	1,149	2,704	7,088
Removed ... ..	—	2,306	6,427

IV.—STRONGEST CURRENT (5·7 AMPERES.)

	A	B	C
In contact ... ..	21,980	23,660	24,040
Armature distance. { 1 mm. ... ..	8,110	10,810	17,220
2 mm. ... ..	5,611	8,464	15,886
5 mm. ... ..	4,056	5,273	12,627
10 mm. ... ..	2,029	4,057	10,142
Removed ... ..	...	3,581	9,795

These numbers may be looked upon as a kind of numerical statement of the facts roughly depicted in figs. 31 to 34. The numbers themselves, so far as they relate to the measurements made (1) in contact, (2) with gaps of one millimetre breadth, are plotted out on fig. 44; there being three curves, a, b, and c, for the measurements made when the armature was in contact, and three others, a<sub>1</sub>, b<sub>1</sub>, c<sub>1</sub>, made at the one millimetre distance. A dotted line gives the plotting of the numbers for the coil c, with different currents, when the armature was removed.

(To be continued.)

## LEGAL.

**Chatenay v. The Brazilian Submarine Telegraph Company, Limited.**—(Before the Master of the Rolls and Lords Justices Lindley and Lopes).—This appeal from the judgment given in the *ELECTRICAL REVIEW* for February 28th, came on for hearing in the Appeal Court on Saturday last.

It was an application under the Companies Act to restore the name of the plaintiff on the register as the owner of 50 of the company's shares.

The plaintiff was a Swiss merchant residing in Rio Janeiro, in Brazil, and in 1880 he executed a power of attorney authorising his agent in London to buy and sell shares for him in England and in all other countries. In 1883 the shares in question, which stood upon the register in his name, were transferred to other persons at the instance of the plaintiff's agent. On the plaintiff discovering that this had been done, he claimed to have his name restored on the register as the owner of the shares, but the company refused to comply with his request, with the result that the present application was made. Mr. Justice Day held that the power of attorney, which was written in the Portuguese language, must be construed according to the English law, which required that the instrument should be supplemented by letters of instructions applicable to each transaction, which letters were not held by the plaintiff's agent in reference to the transaction in question. The company appealed.

Mr. Finlay, Q.C., and Mr. W. Graham appeared for the company, and Mr. H. D. Green, Q.C., and Mr. A. Young for the respondents.

Mr. FINLAY contended that reference must be made to the law of Brazil to ascertain the extent of the powers conferred by the plaintiff upon his agent, and in order to ascertain the intention of the parties. By the law of Brazil, the power of attorney conferred full authority upon the agent to deal with the shares without any letters of instruction being required.

Mr. H. D. GREEN submitted that the document, being intended to operate in England, must be supplemented by all that the English law required.

Their lordships held that the document being executed in Brazil, and being in the Portuguese language, the intention of the parties must be ascertained by competent translators and experts, but that the extent of the authority given by it must be determined by the law of England in the case of transactions in this country. This was a mere expansion of Mr. Justice Day's judgment, and, therefore, the appeal must be dismissed with costs.

**The Tharsis Sulphur and Copper Company v. La Societe Des Metaux.**—This case came before Mr. Justice Charles in the Queen's Bench Division on Saturday last. It was an action brought to recover the sum of £59,186, being damages for breach of contract to accept delivery of and pay for certain quantities of copper.

Mr. Gorell Barnes, Q.C., and Mr. Houghton appeared for the plaintiffs, and Mr. Kennedy and Mr. H. Tindall Atkinson for the defendants.

This case was one of several which arose out of the breakdown of the French combination known as the "Copper Ring" last year. Most of the questions, however, which arose in it had been decided in previous actions brought in the English Courts against the same defendants. The plaintiffs were an English company, incorporated under the Companies' Act, and the defendants were a body of persons incorporated in France. On April 20th, 1888, a contract was made between the parties by the exchange in London of duplicate parts thereof, one of which had been executed by the plaintiffs in Glasgow, and the other by the defendants in Paris. By the contract the defendants agreed to purchase at prices therein named all the refined copper manufactured by the plaintiffs during three years commencing January 1st, 1888. In March, 1889, the defendants went into liquidation. By the terms of this contract, the defendants elected domicile in this country. The amount now claimed by the plaintiffs was the deficiency arising upon re-sales of the copper, of which the defendants had not taken delivery under the contract. The defendants pleaded that, the contract having been executed by them in Paris, was a French contract, and subject to French law, and consequently was illegal and void, inasmuch as it was contrary to Article 419 of the Code Pénal, which, it was alleged, rendered a combination such as this, to affect the price of goods, illegal. Further, that by the French law of liquidation, the plaintiffs could not rescind the contract and recover damages, but could only exercise a right of election between rescinding the contract (without damages) and delivering the copper, and proving in the liquidation for the price. The plaintiffs admitted that the last statement was a correct one of the French law on the subject, but denied the alleged illegality, and contended that the contract was an English contract, and was, therefore, unaffected by the French law. In the case of "Antony Gibbs and Son v. La Société des Metaux" (6, the *Times* L. R., 393), the Court of Appeal, upon similar facts, held that the right to sue on an English contract was not affected by the French law of liquidation, and in "Cape Copper Company v. Comptoir d'Escompte and La Société des Metaux" (6, the *Times* L. R., 454), Mr. Justice Day held that similar contracts were English contracts, and that the rights of the parties were, therefore, to be determined according to English law.

Mr. JUSTICE CHARLES said that, although some of the facts as to the execution of the contract in this case were different to those in the cases referred to above, yet he had come to the conclusion that the contract was an English contract, and that his duty was to follow the judgment of Mr. Justice Day in the other cases, which proceeded on the ground that the parties themselves had agreed that the contract should be subject to English law, and that it was to be performed (and, until the liquidation, had been performed), within the jurisdiction of the English Courts.

Judgment was accordingly given for the plaintiffs with costs; the damages to be agreed between the parties, or, in case of difference, to be settled by the judge.

## NEW PATENTS—1890.

15792. "Improvements in incandescent electric lamps, and leading-in wires therefore." B. J. B. MILLS. (Communicated by T. A. Edison, United States.) Dated October 6.

15819. "Improvements in electric dynamos, electric motors, transformers of electric currents, and induction coils." J. JOHNSTONE. Dated October 7.

16054. "Improvements in electric batteries." H. G. C. SERRIN. Dated October 9.

16055. "Improvements in electric batteries." H. G. C. SERRIN. Dated October 9.

16057. "Improvements in pillars and electroliers or pendants for electric lamps." R. B. EVERED and T. RUDLING. Dated October 9.

16064. "Improvements in electrical secondary batteries." J. K. PUMPELLY and F. BUTTERWORTH. Dated October 10. (Complete.)

16110. "Improvements in the distribution of electricity." T. PARKER, J. H. WOODWARD and E. S. G. REES. Dated October 10.

16136. "Improvements in coin-freed apparatus for obtaining a current of electricity for producing electric light, or for other purposes." H. J. DOWSING and H. S. PRICE. Dated October 11.

16156. "Improving mains for carrying currents of electric matter." J. JOHNSTONE. Dated October 11.

16222. "Improvements in lanterns or lamps for arc electric lights, and in posts or columns therefor." A. L. SHEPARD. Dated October 11.

16223. "Improvements in the parts of electric meters connecting the movement of the solenoid with the calculating train." H. BURROW. Dated October 11.

## ABSTRACTS

## OF PUBLISHED SPECIFICATIONS 1889.

12563. "Improvements in electrical ships' logs, or means for ascertaining by electricity the speed of ships." R. M. LOWNE. Dated August 8. 11d. Claims:—1. A rotator with affixed towing line operating an electrical contact apparatus on board ship, or at any convenient distance therefrom, substantially as shown and described and for the purpose stated. 2. A rotator with affixed towing line operating an electrical contact apparatus on board ship, or at any convenient distance therefrom, in combination with conductors, battery, indicator or indicators, substantially as shown and described and for the purpose stated. 3. The combination of rotator, affixed towing line, battery, contact apparatus, conductor, cable, indicator or indicators on board ship, substantially as shown and described and for the purpose stated. 4. The combination of combined rotator, battery, and contact apparatus, with conductor, cable, and an indicator or indicators on board ship, substantially as shown and described and for the purpose stated. 5. The method of insulating movable conductors substantially as shown and described and for the purpose stated.

14011. "Improvements in switches for opening and closing electrical circuits." A. L. SHEPARD. Dated September 5. 8d. Relates to a switch which ensures the circuit being always either fully open or completely closed, and secures a perfect contact between the fixed and movable portions which serve to convey the current, thereby preventing the formation of arcs at the point of such contact, and consequent damage to or destruction of the apparatus. 6 claims.

14377. "Process of and apparatus for maintaining uniform current in electric lighting circuits." J. M. BRADFORD. Dated September 12. 1s. 1d. In this invention the strength of a variation in the line current is not a necessary factor in securing energy of regulating action; the regulating devices act with an accumulative effect, or in opposition with a differential effect, according to the duration of a variation of the line current, and changes in the line current can be anticipated or prevented, instead of being reduced after they are developed. 10 claims.

14464. "Improvements in electricity meters." E. BATAULT. Dated February 15. (Under International Convention.) 8d. Relates to apparatus or electricity meters based on the principle

which consists in measuring, at regular intervals of time, the length of the tangent of the angle of deviation of the hand of a galvanometer placed in the circuit of the current to be measured, and in registering the sum of these tangents. 4 claims.

14485. "Improvements in magneto-electric bells or generators in connection with telephonic call apparatus." A. GREENWOOD. Dated September 14. 8d. This invention is for the purpose of improving upon switching arrangements by automatically switching the extension bell or bells out of circuit when the magneto generator is in motion, and by automatically switching the extension bell or bells into circuit when the magneto generator is at rest. To accomplish this the inventor utilises the motion made by the generator shaft of a magneto bell in a horizontal and lateral direction; this motion is used in ordinary magneto bells for the purpose of shunting the armature circuit when the armature or generator is at rest, and is made by means of a spiral spring arrangement known as the cut-out. The inventor employs this motion for the purpose of switching off and on the extension bell or bells automatically, by causing the generator shaft, handle and gearing, to break the connection between armature and line or earth (made by a contact spring) when the armature, gearing and shaft are at rest; and by causing the armature to be connected through the said contact spring to line or earth when the armature, gearing and shaft are in motion. 1 claim.

14590. "Improvements in electric bells." H. GROVES and J. H. STEWART. Dated September 16. 8d. The inventors employ but one magnet bobbin, which they erect vertically on the base of the instrument; it has two pole pieces, one above and the other below. The armature they make of T-form, the cross piece or head (which is the armature properly so called) is vertical, and its ends are in close proximity to the pole pieces of the magnet. The armature is attached to and carried by a spring blade fixed to the horizontal stem of the T-piece. 4 claims.

16586. "Improvements in electric switches." T. MARCHER and F. ERNECKE. Dated October 21. 8d. The object of the invention is to prevent any possibility of a middle position of a circuit closer. 3 claims.

17060. "Improvements in electrical furnaces and their manipulation." T. PARKER. Dated October 29. 8d. Instead of using movable anodes of metal or carbon, the inventor uses blocks of carbon fixed in the walls of the furnace opposite to each other, and set at suitable distances apart in the interior of the furnace wherein it is intended to treat the materials at the high temperature of the electric arc or incandescence due to the current. These blocks of carbon are fixed in metal conductors, which may be kept cool by a circulation of water within themselves. The blocks of carbon are arranged with holes through their centres, so that a rod of metal or small rod of carbon may be used to establish the circuit through the furnace. 6 claims.

## CORRESPONDENCE.

### The Lane-Fox Patents.

Permit me to make some remarks upon the article on my patents which has appeared in your last issue. The ELECTRICAL REVIEW has earned the reputation of being both a fair and a well informed journal, and it is with regret, therefore, that I have now to find fault with the inaccurate and superficial manner in which you are now dealing with my "pretensions," as you term them.

Before commenting on the more technical side of your article, I desire to reply to the accusation (for it is nothing less) which you make against myself and my "associates" of not fighting fair. Nobody could deprecate more than we do any unnecessary harassing of innocent, that is to say, unintentional, infringers of my patents. Our desire throughout has been to select the right people—the "foemen worthy of our steel," as you so poetically express it—and failing more conciliatory methods of obtaining our just rights, to fight them. When you insinuate that the opposite has been our policy, you convict yourselves either of a deliberate perversion of the true history of our course of action since my settlement with the Brush Company last December, or else—as I prefer to believe—of a misapprehension founded upon ignorance of the facts. If I am right in this latter construction, I am sure you will gladly allow me to correct you by assuring you, what you can easily prove for yourselves, that it is only quite recently, and after exhausting all the more direct methods of drawing out our real opponents, that we were reluctantly obliged to force their hands by

"having a go" at their customers. In so acting we have, after all, only tardily taken up the gauntlet thrown down to us by a certain organisation started by our opponents (and whose manifesto you have already made public in one or more of your August issues), which made a direct appeal to the "consuming" public to co-operate with them against us. In the case of the well-known electric light supply company, against whom we first had occasion to direct our fire, our attack was evidently far too direct for their liking; for instead of taking up our challenge at once, they have put us off with what I can only characterise as an alternation of bluster and prevarication, the motive of which we now assume to have been to gain time for the concoction of an elaborate defence. However all this may turn out, we may certainly claim freedom from the reproach of cowardice.

But although rather glad than otherwise of this opportunity to put yourselves and your readers on the right clue to our motives in the somewhat uncongenial procedures to which you have referred, I do not wish to take up any more of your space with this part of your attack on myself and my friends. I confidently leave our fuller justification to the future.

Now as to my inventions themselves. In complaining of the *simplicity* of my system, you are according to it the highest praise which I could desire for it. To say nothing of the familiar story of Columbus and the egg, a powerful judgment was recently delivered on a patent case in the Supreme Court of the United States, in the course of which this very quality of simplicity (in conjunction, of course, with efficiency and utility), far from being adduced in disparagement of the patent's validity, was extolled as the sign-manual of the highest merit which an invention could possess. There are some people, it is true, who are under the impression that a patent, to be of any value, should in some way or other transcend the laws of nature, if not actually conjure into operation some new or mythical force. I should be sorry, however, to attribute such puerile reasoning either to yourselves or to the generality of your readers.

Next I desire to deprecate the assumption which I note in your article—and which may encourage others to assume—that certain combinations for electric lighting purposes now quite familiar, were always matters of common knowledge, or at any rate that they were so at the date of my chief patent (1878). No one who had experienced a fraction of my difficulties, between then and 1881, of convincing even the scientific world of the theoretical, to say nothing of the practical feasibility of my proposed system, would fall into this mistake. I do not wish to quote in this connection certain eminent electricians now living, until I have their express authority for so doing—an authority which I believe will not be denied to me if and when I may deem it necessary to request it. But I feel at liberty at least to mention that the late Sir William Siemens and also Mr. William Spottiswoode, then President of the Royal Society, both expressed their strong opinion at a meeting of the Society held in 1879, that the distribution of the electric light, then beginning for the first time to be talked of, was from theoretical considerations a thing not to be hoped for. (It will be remembered by many of your readers that the telephone and the phonograph, when first heard of, were similarly ridiculed by contemporary electricians of high standing.)

To illustrate the kind of treatment which the subject of distribution received at that period, it may be mentioned that Edison's first patent for electric lighting (the application for which is dated a few weeks later than my own), which was for nothing more than the operation of incandescent lamps in *series*, with a special regulating device for shunting the current across the lamps whenever the latter became too brilliant, was loudly proclaimed as a grand and fundamental discovery of the means of distributing electric light. My plan of maintaining a constant *potential* in electric mains, notwithstanding any variations in the number of lamps in action, was certainly, so far as I have been

able by careful and protracted investigation to ascertain, quite unthought of at that date, and, in spite of all my efforts, my patent attracted but little attention. As to the modern incandescent lamp, specially adapted for the system which I claim to have been my invention—a lamp, that is to say, in which the luminous surface, resistance, and candle-power are adjusted to suit a fixed potential of the mains—it would have had no *raison d'être* at that date, or until my system began to be applied; consequently this system, although *simple* enough truly, cannot be fairly summarised (as you seem to suggest that it should be, and as other objectors have also suggested), as merely an *obvious* combination of already well-known elements. Even if this were the case, by the way, the patent itself would not on that account necessarily be invalidated.

From the above considerations it will be sufficiently evident that both of the two instances of alleged anticipation which you quote are quite fallacious. In the case of Farmer's "demonstration," primary batteries were used in connection with platinum wires or strips; but neither was my combination employed, nor even one of its most essential elements, viz., the modern incandescent lamp, constructed on the principles described in my specification; nor was there any hint of the importance of maintaining a constant potential difference or the means by which such could be obtained. On this point the note on Sir David Salomons's reference to the proposed use of primary batteries for incandescent lighting, which you publish on page 496 of the same issue under the heading of "Electric Light and Potential Difference," is singularly opportune. The other instance, namely Breguet's experiment at Paris in 1877, may be disposed of by a similar process of analysis, for although of course the use of secondary batteries gives a fictitious appearance of analogy, the fundamental idea of multiple arc distribution of electric light at a constant potential is wholly absent.

Briefly as to the present position of my "troublesome claim." The only claim for which I am now endeavouring to obtain a substantial (but financially moderate) recognition, is for my combination, as more fully described in the specification of letters patent No. 3,988,\*\* of 1878, of a system of incandescent lamp distribution in multiple arc, at a constant potential, with secondary batteries as reservoirs of electrical energy.

One last word. If by your reference to the Brush Company's attitude towards my "pretensions," you mean to imply that they have not recognised the validity of my patents—the only sense in which I can see any force in your remarks on this point—I cannot imagine who your informant may have been, but must assure you that you are entirely mistaken. The differences between us were quite of another kind.

St. G. Lane-Fox.

P.S.—October 28th—I have just received a letter from General Webber, in which he says: "In writing to the ELECTRICAL REVIEW you have my authority to state that when I was acting as managing director and engineer of the Anglo-American Brush Corporation the validity of your distribution patent was held to be as good as that of any which had actually not been contested in the courts of law, and that at that time the Anglo-American Brush Corporation had every intention of bringing the same to an issue."

#### Telephone Switchboards.

I have read with interest the description of the improved switchboard and switching system, invented by Mr. D. Sinclair, and beg of you to allow me space for a few questions thereon, viz.:—

1. Is the system intended for metallic return, or for only single metallic circuits?

2. How are the connections of the telephone, transmitter, magnets, bell, &c., formed in the circuit of the plug, indicator and jack?

3. Have the indicators one or two coils or cores?

I admire the simplicity of the arrangement, as shown,

which is an important consideration in telephony, and should commend itself to those engineers who are responsible for the planning and fitting up of exchanges in the future.

Z.

#### Accumulator Management.

In reply to the question of "B. B." as to how much soda should be added to one gallon of the ordinary dilute acid electrolyte, I think I may say that in many cases one ounce would be a good proportion, although sometimes more may be used with advantage if the plates are badly sulphated. Carbonate of soda (ordinary washing soda) must be used, and on no account commercial sulphate of soda.

W. J. S. Barber Starkey.

October 25th, 1890.

#### Accumulator Explosions.

Referring to the reported explosion on Lord Poulett's yacht, I well remember a similar accident on board the *Giovanni Bausan*, an Italian warship, which was fitted with electric light under my superintendence, by Messrs. Armstrong, Mitchell & Co., in 1885.

The cells in this case were contained in teak boxes with a small aperture plugged with a cane stopper in the lid, and the explosion occurred owing to one of these plugs being withdrawn, and a lighted candle applied in order to see whether the cell was giving off gas during the process of charging. Only one cell went off, but the teak case was split into numerous fragments, the plates were bent, and the acid splashed about. No one was injured, but the noise was exceedingly loud, and there was a remarkably vivid flame.

Considering that oxygen and hydrogen gases, mixed in the right proportion, form, weight for weight, the most energetic explosive known to science, the matter is perhaps not so very remarkable as some may think.

A. A. Campbell Swinton.

October 24th, 1890.

An accurate account of an explosion similar to that on Earl Poulett's yacht may be of interest at this moment.

This explosion took place last week on board the Clyde training ship *Empress*, where a set of 26 teak cased cells have been placed as part of the lighting plant. The cells are of the ordinary yacht pattern, viz., sealed with the exception of the small vent hole on top and are placed on an open rack in the engine room, where they are quite free from damp, and as there is a large porthole open behind the rack the ventilation is all that could be desired, in fact the draught is so strong that it is with difficulty a naked light can be kept burning near the cells.

The lid had been removed from one of the cells that the hydrometer might be seen, and it was when the engineer lit a match to look into this cell the explosion took place, destroying one cell on each side of the open one. No explosion seems to have occurred in the open cell, as the hydrometer was not injured and although the outer plates were bent and the lead lining driven in this may have been caused by the fragments of the burst cells striking the outside.

Judging from the condition of the two damaged cells the force of the explosion must have been considerable as the upper half of each cell was not merely burst open, but the woodwork was shattered into small pieces and the brass terminal screws which are cast into the lead were pulled right out.

The dynamo was running when the explosion took place and the cells were gassing freely having been charging about 26 hours (the cells being new). The fact that only two cells exploded may be explained by the draught carrying the gas away from the cells, and

not along the row and the vertical supports of the rack, partly isolating these three cells from the others.

Fortunately no one was near the battery at the time except the engineer, and he escaped with a bruise caused by a flying piece of wood.

Mr. Edmunds's suggestion in your last issue cannot be applied to this case as the cells were under cover and there was certainly no damp about any of the connections.

The cause of the accident seems clear, and the remedy is very simple. It is just as easy to use an incandescent lamp as a match or a candle, and in the interests of the electrical industry the danger of naked lights should be impressed upon those who have dealings with this type of accumulator.

J. Hunter.

October 27th, 1890.

The following account, *apropos* of explosions in secondary batteries, may possibly interest readers of this journal.

About five years ago, whilst charging a batch of E.P.S. 17 S teak cells (lead lined), I was engaged in tightening up the nuts on connecting strips, and in so doing accidentally short circuited one of the cells with the metal spanner I was using. Immediately there was a loud report, the teak lid (firmly screwed down and cemented) flew into fragments, and one side of the box was split from top to bottom, but the lead lining fortunately remaining intact, no leakage of solution occurred; the sections moreover, were undisturbed, as proved by the fact of this very cell having outlived all the rest of the battery, and expiring from genuine decay but a few days ago.

The cause of the explosion was, to my mind, to be easily accounted for in this wise. The lid possessing a vent hole (for the escape of gases), situated near one of the terminals of the cell, contributed a direct supply of the gases for any sparking which would ensue in the event of a short circuit being temporarily effected between the conductors.

On Lord Poulett's yacht the battery appears to have been to a certain extent enclosed, thus rendering free escape of gas in a heavy, wet atmosphere, more unlikely to occur than if the weather had been fine at the time, consequently the explosive mixture readily found its way below deck *via* the cable channels, thus establishing a direct connection between battery and source of ignition.

I fail to see how the general public can be expected to support and favour the new illuminant, if instructed by scientific (?) paragraphs, as provided by some of our daily papers.

Lyndhurst.

#### The Sweating System.

In your issue of October 10th a correspondent signing himself "An Electrical Trades Unionist," makes an onslaught of a most ferocious character upon what he has chosen to call the "Sweater." By the tenor of his letter I am inclined to think that this gentleman would have better borne out his character had he signed his effusion "An Electrical Trades Monopolist." His object seems to be to stamp out "the little man." to improve him off the face of the earth, so that the whole industry may be in the hands of enormous Syndicates, otherwise Limited Liability Companies. Personally, I should say that this letter to which I have referred was a "bogus" letter and not written by a unionist at all, but by a capitalist, or an emissary of such. My experience is that the small man pays his workmen quite as well as the big one, and in many instances better. I have paid linemen 1s. per hour. How many large firms pay their men more than half that sum? The breakdowns to which "E.T.U." alludes, do no harm to the industry at all. They simply open the owner's eyes, and he hands his work over to someone else in the future. Breakdowns, Sir, are more due to the ini-

quitous state of the law, which permits installations to be superintended and managed by grooms, gardeners, odd job men and "master Johns," in place of having a competent man. And I can tell you, Sir, that the big firms of our friend "E.T.U.'s" fancy are more to be blamed than anyone for this very thing. The small man is generally a practical man who works himself. The work done by a big firm is generally "bossed" by some kid-glove pupil who cannot make a common solder joint. I can give chapter and verse for what I say, and every man who reads these lines, if he has had any experience at all, can vouch for the truth of it. Why, Sir, one of our largest firms at one of our great exhibitions placed the management of the installation in the hands of one of these automatons, and the initial performance of this representative of "a first-class firm" was to switch on with the voltmeter in series with the main circuit. This sweating charge is humbug, Sir, when applied to the small tradesman. It is the big firms who piece-work the men who do all this, and I should say that no one knows this better than Electrical Trades Unionist himself.

A Small Manufacturer.

October 26th, 1890.

#### The Invention of the Telephone.

We are all familiar with the earlier telephonic experiments of Reis, which are given in the *Jahres Bericht des Physikalischen Vereins*, of Frankfort, for 1860-1861, and which are regarded as the precursor of the telephone of Graham Bell. Prof. Bell read a paper on the subject before the Society of Telegraph Engineers on 31st October, 1877, and at this lecture I called attention to a still earlier description of a telephone by Charles Bourseul, which is to be found in the second edition of the Comte Theodore du Moncel's *Exposé des applications de l'électricité*, published in Paris in 1857, Vol. 3, page 110. Du Moncel does not give any reference to the original paper, but in the *Didaskalia*, a weekly paper published at Frankfort-on-Maine, No. 232, dated 28th September, 1854, there is an interesting account of his invention, which I do not remember to have seen printed in England. I am indebted to Messrs. Siemens Bros. & Co. for making the translation, which I enclose, and if not hitherto published, it will, I am sure, interest your readers, as his description of the principle of the telephone is almost as clear as if it were written at the present date. If he had only put his ideas to the test of experiment, we should have had the telephone in 1854.

It would be interesting to find the original source from which Count Du Moncel derived his account of Bourseul's telephone.

Latimer Clark.

October 28th, 1890.

[Full particulars of everything mentioned by Mr. Latimer Clark have from time to time been published in the REVIEW. Bourseul and the *Didaskalia* were quite familiar names in our pages of years ago, through the contributions to the subject of telephony so frequently published from the pen of Major W. C. Barney.—EDS. ELEC. REV.]

#### Semaphore Telegraphs.

In your next issue, will you please oblige me by saying where I could find a sketch of the old English semaphore telegraph used up to the introduction of electric telegraphs.

If you could give a sketch, I should be greatly obliged.

J. H. Tattershall.

Postal Telegraphs, Rochdale.

[We regret we have been unable to find the information you require; perhaps some one of our readers may be able to furnish the desired reference.—EDS. ELEC. REV.]

THE TELEGRAPHIC JOURNAL AND  
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THE ELECTRO-DEPOSITION OF  
COPPER.

IN our correspondence columns we publish a letter from Mr. W. Stepney Rawson which necessitates a few remarks on our part. We have to thank Mr. Rawson for his letter. If he only appreciated our anxiety to place before our readers any information we can obtain which would help them to arrive at a correct judgment on the question he would have made his letter longer, and we should have been glad to find room for any facts and figures it might have contained. Our correspondent writes apparently in some haste and with some warmth, but we must make allowances for one who, having only just returned from abroad, seems scarcely at home with his subject.

Mr. Rawson has selected eight points from our recent articles on the electro-deposition of copper, in order to demonstrate how utterly in the wrong we have placed ourselves, and he doubtless thinks that any reply we can make will be of little avail; that, however, we are content to leave to the unbiassed judgment of our readers. It will be noticed that our calculations and deductions are held to be practically ridiculous, whatever that may mean, although the writer takes care not to give any figures to show that they are theoretically incorrect; but we will let that pass, and assume, for the sake of argument, that Mr. Rawson's knowledge of the electro-deposition of copper is far greater than that of any of the eminent scientists and authorities we have credited with the responsibility of certain data. Let us also take it that the figure quoted on the authority of Mr. Sprague, viz., "that the maximum allowable current for obtaining proper deposition is 18 ampères per square foot of surface of the electrodes," is more than double of what is possible in ordinary commercial depositing, and reduce it, say, to 7 ampères; and, according to Mr. Rawson's assertion, we will admit that in the Elmore process the current density is three times this amount. The difference between this result and the figure taken by us for our cal-

culatation is so small that we fail to see the force of his contention, especially as we clearly stated that probably by the use of the burnisher a somewhat heavier current might be employed per square foot of surface.

Mr. Rawson is equally at fault on the horse-power question, for he has not taken into consideration our article of the 24th ult., in which we compared a German establishment working 144 hours per week with the Elmore factory on Dr. Hopkinson's estimate of 161 hours.

It is not for us to reconcile the figures of cost on p. 479 with anything whatever; they are not of our compiling, but are given by Fontaine as the actual expenses in three works. It is for our correspondent to show that the Elmore process does not involve an expenditure of more than one-third of the amounts there given as the experience of years. The power, it will be observed, in this table varies from 20 to 50 per cent. of the total cost; which of these percentages does Mr. Rawson deem most applicable to the Elmore case? Let him read more carefully what Fontaine says regarding the cost of fuel; the French authority quotes only 5s. per ton, and yet asserts that motive power costs in Birmingham 125 francs per ton of copper. Mr. Rawson, therefore, instead of being surprised that we dared to estimate the expenses of electrical deposition on an assumption opposed to experience, should have set himself to work to show how the figures we gave as the results of actual practice can so differ from those which he presumably possesses but fails to produce when wanted.

We have shown, by an exhaustive comparison with the Mouchel copper, why there is no reason to anticipate any extraordinary demand for high conductivity Elmore copper wire; Mr. Rawson simply asserts his belief that the company can show a handsome profit in this department; indeed, his communication is entirely made up of assertions and opinions, but not one fact does he bring forward in support of them.

We beg to assure Mr. Rawson that if he will again carefully peruse our comments, he will fail utterly to

find any reference reflecting on the quality of the articles. With regard to the last paragraph of Mr. Rawson's letter we may say that we have no intention of discussing with him the question of high principles, and we venture to think his letter would have been improved by the omission of the sarcasm. As he has undoubtedly misunderstood the purport of some of our remarks perhaps we ought to make them clear to him. We examined the patents and the reports on them as we examined other points. We found the general exaggeration to be common to them too. The value of the patents was the question. Messrs. Woodhouse and Rawson should be aware that if an invention is successful there are always people ready to "steal the ideas of the inventor," as our correspondent puts it. The object of a patent is to prevent their doing so, and the value of a patent depends upon the extent to which it does prevent their doing so. Any flaw which may exist is taken advantage of in defending a patent suit; and the possibility of the existence of such flaws is a most material factor in considering the value of a patent. The only surprise to us is, that with Messrs. Woodhouse and Rawson's practical experience in this particular line, they should have failed to give due importance to this consideration. Mr. Rawson's trained mind has enabled him to observe in our remarks on this point a sinister suggestion which they were not intended to contain; nevertheless, we imagine that the same high principles which influenced his firm to promote company after company on the strength of the Elmore patents, will not be entirely absent from the minds of future inventors who would also like to participate in the benefits to be derived from electro-deposition.

We need not remind our correspondent that it is through no fault of ours that we have failed to see the process; will he now, as we are unable to do so, publicly give, in a table similar to that to which he refers on page 479, the various details which go to make up a total cost of but £5 per ton for Elmore copper?

A contemporary last week published an article from the pen of Dr. Gore, in which we consider there is much to support our previous contentions, and the writer concludes thus:—"In consequence of the numerous circumstances which affect the cost, an approximately satisfactory estimate of the total amount of capital required to be invested in establishing an electrolytic refinery to deposit a given amount of copper daily, can only be arrived at by means of a knowledge of all the essential particulars in the given case."

As Mr. Rawson is perfectly conversant with "all the essential particulars" we require, let him place, then, before us the items mentioned in Dr. Gore's *Recapitulation*.

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## THE CITY AND SOUTH LONDON RAILWAY.

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THE inauguration of this enterprise on Tuesday afternoon was a great success in almost every respect, and we must congratulate the City and South London Railway

Company and its officials not only on a splendid engineering achievement, but also on the excellent social arrangements during the opening ceremony. Punctually at noon, their Royal Highnesses the Prince of Wales and the Duke of Clarence and Avondale arrived at the City terminus, where they were received by the chairman of the company, Mr. C. G. Mott. After descending the hydraulic lift in its handsomely furnished cage, the Prince of Wales proceeded to turn a small switch with a gold key, giving thereby the signal for the current to be turned into the conducting mains. This act was witnessed by the Lord Chancellor, the Lord Mayor and the Sheriffs; Mr. J. H. Greathead (engineer); Mr. T. C. Jenkin (manager); Mr. H. H. M. Smith (secretary); Mr. C. E. Spagnoletti (consulting electrician); General Hutchinson and Major Cardew (Board of Trade); and Sir John Fowler (consulting engineer).

Ten minutes later, after examining the electric locomotives and carriages, the Prince and some forty gentlemen boarded the train, which consisted of two saloon cars. The engine was in charge of Mr. W. Mather, M.P., and Dr. Edward Hopkinson, and it was driven by Mr. G. A. Grindle, accompanied by Dr. John Hopkinson. Nine minutes later the Oval Station,  $2\frac{1}{2}$  miles distant, was reached, the intermediate stations—Borough, Elephant and Castle, and Kennington—being passed without a halt. After examining the Oval Station and its equipments, the party re-entered the train and proceeded to the South-West terminus at Stockwell. An excellent luncheon was then served in a tastefully-decorated Indian pavilion, where about 300 invited guests sat down. Mr. C. G. Mott presided, having on his right the Prince of Wales and on his left the Duke of Clarence and Avondale. Besides the gentlemen previously mentioned there were present:—Sir F. Abel, Sir F. Bramwell, Sir B. Baker, Sir H. Roscoe, Sir Douglas Galton, Sir E. Reed, M.P.; Mr. Causton, M.P.; Sir John Monckton, Sir H. Tyler, Mr. Henry Tate, and other notabilities. The electrical fraternity, not directly connected with this enterprise, was represented by Sir David Salomons, Dr. Silvanus P. Thompson, Mr. W. Raworth, Mr. A. P. Trotter, Mr. A. Reckenzaun, and Mr. F. Wynne.

After luncheon, the Prince of Wales, when replying to the usual second loyal toast, proposed "Success to the City and South London Railway" in most appropriate and happy terms. The Chairman acknowledged the compliments of His Royal Highness and stated that the design of the railway was that of Mr. Greathead, who had carried it out under his own superintendence, aided by the company's consulting engineers Sir John Fowler and Sir Benjamin Baker.

Running, as it did, under the streets, without interfering with property on the surface, the undertaking promised to be remunerative. With regard to the motive power, it was originally intended to be worked by an endless cable, but the directors had decided that this plan was not the best for their purpose, and consequently adopted electricity, on the method suggested by Messrs. Mather and Platt, worked out by Dr. Edward Hopkinson, in conjunction with his brother Dr. John Hopkinson.

As we are giving a complete description of its technical details in another column, we shall only dwell upon the general impressions formed both at a private view and during the opening celebration. We were particularly struck with the novelty and originality of construction which was apparent on every side, and this is the best testimony to the genius of the originators of this extraordinary enterprise. Every praise is due, not merely to the engineers and architects for designing a great work which combines utility and comfort, but also to the pluck of the directors and shareholders who had unlimited faith in the abilities of the technical staff.

Although the method of working a train electrically is not new, the scale upon which electric propulsion is carried out is, in this case, quite unprecedented; it is the largest undertaking of its kind in the world, and we believe it will be the forerunner of even greater things in this domain. The City and South London Railway Company has the advantage of knowing beforehand what its traction expenses will be, for the enterprising contractors, Messrs. Mather and Platt, guarantee that for the first two years it shall not exceed  $3\frac{1}{2}$ d. per train mile. On the Metropolitan Underground Railway, where steam locomotives (the product of 50 years' inventions and improvements) are used, the haulage cost is 10d. per mile, with a train capacity of 450 passengers. But these require much larger tunnels, and have to maintain a permanent way twice as heavy to accommodate their steam and smoke emitting locomotives.

Messrs. Mather and Platt have carefully calculated the probable expenditure of energy, and based their estimate upon well-known facts. Out of every 100 units of power developed by the boilers, 75 will be given out in electricity by the dynamos at the generating station; the average loss in the conductor will be at most another 5 per cent., rising from nothing at the central station to 10 per cent. at the extreme end of the line. Leakage, with the system of insulation adopted, will be almost *nil*. It is claimed that the motors give an efficiency of 90 per cent., and, since there is no gearing, the armatures being placed directly upon the driving axles, there should be a total estimated efficiency of 64 per cent.; if, in practice, the efficiency should not reach this high percentage there need be no alarm, considering the fact that the stationary boilers can be fed by burning coal of a quality which is not much more than half the price of best Welsh coal necessary in steam locomotives.

Accidents do happen, even on the oldest and best regulated railways. That the City and South London Railway is not exempt from this law was demonstrated on Tuesday afternoon. After luncheon at 3.30, a large party proceeded to the Stockwell Station platform, to be conveyed to the City as a *finale* to the day's programme. They waited until after 4 o'clock, but no train came in sight, and then the chairman announced that through some accident no more trains would be run that afternoon, and the guests thereupon dispersed to return by any of the existing conveyances on the surface roads. Too much importance must not, however,

be attached to this incident, for the initial proceedings are necessarily incomplete, and smooth working will follow with experience.

It is claimed that this railway has a great advantage over others in the way of safety to passengers. In the event of a train breaking down, the current will be cut off from the section, and it cannot be run into by a train following. The passengers can get out and walk to the next station, which in no case exceeds a distance of one-third of a mile.

The safety appliances on the line, as on the trains, leave nothing to be desired, and altogether the whole scheme deserves the admiration and encouragement of all.

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#### Storage Batteries.

IN letters written by Mr. H. W. Miller, Engineer to the Kensington and Knightsbridge Electric Lighting Company, and Prof. A. B. W. Kennedy, Engineer to the Westminster Electric Supply Company, with reference to the Crompton-Howell storage accumulators, testimony is given as to the efficiency of the same, as the result of four years' working. Although there appears to be satisfactory evidence that the cells are doing excellent work, a few more definite figures would have been advisable. Mr. Miller, for instance, states that in his opinion "an average renewal of six to seven per cent. of the positive plates is enough." Why could not the actual renewals have been stated; were they actually greater than six to seven per cent., and if so, why? The efficiency obtained in practice is stated to be 85 per cent., a good result. Prof. Kennedy makes no remarks on depreciation, except that after 11 months' use nothing in the way of repairs had been done, a rather valueless statement. The battery appears to stand a heavy current being drawn from it without injury, a current of 250 ampères for half an hour having been taken on an emergency, the nominal capacity of the whole being 500 ampère hours. In view of the trouble so often experienced in the management of accumulators, it is satisfactory to find really good results obtained.

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#### The French Elmore Company.

THE directors of the French Elmore Company have issued a circular to their shareholders announcing the appointment of Mons. Secretan as manager, and the issue of £50,000 debentures to the parent company, to provide the additional working capital which becomes necessary by reason of Mons. Secretan's belief in the process and the greater developments which may, in consequence, be expected. We can only characterise the circular as an elaborate puff with no solid substance in it. We have already given our advice to the shareholders. As this circular has been widely published, it may not be out of place to caution those who are not shareholders against being misled into believing so on the faith of any statements whatever short of accomplished facts.

## FRAUDULENT AND DOCTORED TELEGRAMS.

THE trial and conviction at the Central Criminal Court last Saturday week of an individual vaguely described as a commission agent, but who, more correctly speaking, should be called a telegraph clerk, and who was recently in the service of the Government, provides a fitting sequel to a series of fraudulent operations, which had for their object the plundering, by a system of deliberate swindling, of those apparently indispensable "professional" gentlemen who both on the racecourse and in town carry on the sporting business of "book-making."

For the professional racing man, whether "booker" or "backer," we have no particular feeling of sympathy or admiration, and though his praises have been sung very frequently in public, we suspect that the burthen of such adulatory lays have almost invariably been inspired, if not directly at least indirectly, by something approaching a "vested interest" in the ramifications of his quasi-equine profession. The threadbare argument of the almost romantic love of Englishmen for horses is one which has often been used to account for the mushroom-like growth of our racecourses; the amazing increase in the number and value of the races run, and the extraordinary prices given for thoroughbred stock, to say nothing of the fancy sums necessary for the propitiation of the "favourite jockeys" of the present day. However charming and soothing such sophistry may be, it does not offer a substantial explanation of our national extravagance on this peculiarly British subject, and the few apologists who argued the consequent improvement of the English thoroughbred as likely to be worth the price paid for it, have now retired into the region of utter darkness. There is one thing pretty certain, and that is this, that the "professional sportsman" has not got many high-fangled notions as to the sentimental or romantic; least of all in horse lore; it is plainly "win, tie, or wrangle," with him. The money is the sport and the spoil; the love of the horse once so desperately pleaded is merely a means to an end. Remind the average racing man of the classics of the horse; attempt to draw his impressionable soul into the history; more or less mythological, of Abaster, Aethon, Arion, Bayard, Borak, Rosinante, Xanthos, Sleipnir, or even such comparatively modern and material equine worthies as Bucephalus, Copenhagen and Black Bess. With the exception of perhaps the latter, he will know nothing of them; and to throw a light on his darkness he will probably ask what race they ran in, what weights they carried, and who trained them.

It was not the love of the horse which led the young man, Henry Ives, to the plotting and planning of an ingenious, yet artful and unprincipled scheme for the systematic swindling of the betting man, Pratt. Ives's plan, which we shall describe, was one which necessitated the aid of a confederate or confederates in the Central Telegraph Office; and, though it had been planned and resorted to before by a clerk not now in the telegraph service, and who cannot be found by the police, yet, sad to say, there were those who were willing to run the risk of detection and disgrace for the prospect of gaining a few pounds criminally and dishonestly. We will suppose a race as being set for decision at two o'clock. Henry Ives handed in a telegram addressed to "Jackson, High Street, Sunderland," at about a quarter to two. The address on the telegram was a bogus one, as was also the text, but it enabled the message form, which was timed 15 minutes or so before the advertised time of the race to reach the hands of the confederate, who was probably engaged at or near what is known as the Sunderland circuit. Here it was detained until the result of the race was known, then the address and the text, which had been lightly written, were erased, and a new and correct address having been substituted, the text was altered to a request to back so and so (the actual winner) for so many pounds; the message was then put rapidly into circulation, and delivered to the addressee, a betting

man. Ives had the authority of another betting man, named Miller, to use his name; Pratt, the recipient of the telegram, would, unless suspicions were aroused, imagine the telegram, from the early time it bore, to be a genuine one from his "client," Miller, and would book the amount to his credit accordingly.

It is quite possible that this clever, though unprincipled scheme, has been managed successfully before; but how often, of course, will never be known. It is probable that the large sums which were being put on in the name of Miller, and the unvarying success attending their outlay, aroused the suspicions of Pratt.

The jury had no difficulty in finding a verdict, and the plea usually put forward on such occasions in extenuation of guilt was once more forthcoming.

Henry Ives, like many others in his unfortunate and disgraceful position, advanced the time-worn excuse of being the dupe of others, who were older.

It may be the business of legal gentlemen, when all other excuses fail, to put forward the plea of "the dupe" in defence of their clients, but such generalities ought not to stand in the way of the punishment of the swindler and the thief.

The fact that sentence was deferred indicates that there may be some effort made to get Ives to say who has duped him; but anxious though most people are to see justice tempered with mercy to those who yield to sudden and overwhelming temptation, the circumstances of the case under notice suggest that there was neither sudden temptation nor temporary failure of moral rectitude, but rather that the whole matter was the outcome of a cunningly contrived, and ingeniously carried out, system for subverting the working of the telegraphic system to the nefarious ends of unprincipled and lawless men.

The Postal Telegraph Service derives a large revenue from the professional racing man, and, indeed, in this respect, our Government presents a strange anomaly, for with one service it caters and canvasses for the custom of racing men by extending telegraph communication to every conceivable place where racing of any importance is carried on; and with another institution, namely, the police, it gloriously upholds the State enactment that betting is illegal, and in the newspapers we may read that 10,000 messages were despatched on Derby Day from Epsom, or from Doncaster on the St. Leger Day (and what were they if they were not betting messages?), and in the next column find that the police have made a most successful raid on betting men, and that the magistrates have imposed heavy fines. Doubtless, with the elimination of the bookmaker, the interest in racing would become languid and tame, and if any excuse can be made for retaining him, it may be found that in the present condition and routine of society he is, as Robertson, in his comedy of "Ours," has said of matrimony—"a necessary evil, which at present we are unable to do without."

Betting, as carried on at the present time, seems to be an ever-growing practice of at least doubtful respectability, and, possibly, is able to boast as a business that it is not over-stocked, even in these days of limited trade and unlimited labour. The racing man's so-called love of the horse is the offspring of mercenary practices, and may be gauged by the volcanic explosion of appalling language which follows the defeat of the "beloved" steed, to whose chance of "getting home" he had entrusted some portion of his ill-gotten wealth. His anguish at such times may possibly partake of the classic, though this cannot be said of his love of the racehorse, or, indeed, of his language.

At all events, it must be admitted that he is entitled to the same measure of fair play, consideration, and protection at the hands of the telegraph service as any other person making use of its lines and *employés*, and it may be that Henry Ives, in durance vile, will have plenty of time to think of the squandered years and lost opportunities of his young life, and make resolves for a better future, or he may prefer to plot and plan some other ingenious combination of intelligence and cunning which will hereafter still further advance him on the road to ruin.

A SYNTHETIC STUDY OF DYNAMO  
MACHINES.

(Continued from page 356.)

IX.—THE HEATING OF MACHINES (*continued*).

THE temperature which an armature will attain in running depends upon the heat generated due to the three causes already mentioned, on the extent and character of the surface from which the heat is radiated, and on the velocity at which the surface is moving. Generally speaking, the exterior surface of the armature is smooth, but the periphery velocity varies from 3,000 feet per minute in direct current machines to 6,000, or even 8,000 feet per minute in alternators.

As may be imagined, it is difficult, if not impossible, to foretell precisely the extent to which the motion will be effective in dissipating heat, though for ordinary calculations it is assumed that a surface velocity of 3,000 feet per minute is equivalent to adding about one-half to the radiating surface. This, in other words, means that if the temperature of an armature at rest were raised 30° with the normal current, the temperature rise for a velocity of 3,000 feet per minute would be, neglecting hysteresis, only 20°.

For stationary coils wound with double cotton-covered wire, and varnished on the exterior, the equation connecting the rise of temperature with the radiating surface, and the power dissipated is approximately

$$C^{\circ} = \frac{W \ 330}{S}$$

where  $C^{\circ}$  is the rise in degrees Centigrade,  $W$  the rate at which energy is dissipated in watts, and  $S$  the area of the radiating surface in square centimetres. If the coils are wound on an armature and have a surface velocity of 3,000 feet per minute, the effect being equivalent to increasing the radiating surface, we have as approximately expressing the relation

$$C^{\circ} = \frac{W \ 220}{S}$$

There is a considerable amount of uncertainty as regards the latter formula, since the part which the surface speed plays in dissipating the heat depends entirely on the construction of the machine. In most armatures wound on the Gramme principle, for instance, the wire in the interior of the core presents a broken surface, which is manifestly more effective in getting rid of the heat than a smooth surface. Again, the spider arms are very often twisted to send a draft through the interior, or spaces are left at intervals in the core, through which the air is propelled by centrifugal force. In drum armatures, a space is sometimes left between the spindle bush and the central opening in the discs. But this space would have little value as far as dissipating heat is concerned, were it not that by twisted vanes or other means a draft is forced through the opening, and without experiment it is difficult to determine the effect a current of air created in this way will produce. The surface velocity makes a great difference to the capacity for dissipating heat, even if the surface is smooth, and there is no forced draft. Mr. Rehniewski considers that the heat which can be dissipated by an armature for a given rise of temperature above the atmosphere is nearly proportional to the peripheral velocity, in which case, taking the effect due to 3,000 feet per minute as indicated by the difference in the coefficients of the two equations, we have the rise in temperature represented by

$$C^{\circ} = \frac{W \ 330}{S \ v \cdot 0005}$$

where  $v$  is the surface velocity in feet per minute. In accordance with this assumption, the value of the surface for heat dissipation is 1.5 times greater when running at 3,000 feet per minute than when at rest,

while at a velocity of 6,000 feet it has three times the value. The writer has, however, been unable to test the truth of this supposition, and it is probably best to assume, in the absence of experiment, that the equation holds good only to 3,000 feet per minute, at which velocity plenty of experiments have been made. After this speed is reached, it is possible the proportionality may fall off somewhat; but if the surface is calculated as for 3,000 feet, the machine, at a higher speed, will have the advantage of running cooler.

Of course, the rise in temperature above given relates only to the exposed surfaces of the coils. In the case of stationary close-fitting magnet coils, the temperature next the sheet iron core on which they are wound is higher than at the external surface, but experiments to determine the difference of temperature between the inside and the outside have not been made so far. This difference of temperature may be expressed as the thermal pressure required to send the current of heat through successive layers of cotton-covered copper wire and insulating materials composing the coil, the flow taking place partly from layer to layer through bad conductors, and partly round and round the coiled wire. Though in estimating the cooling surface it is usual to neglect the flanged ends of the cores and the surface next the magnet, counting only the area of the exposed wire, there is undoubtedly some flow of heat towards the interior of the magnets and towards the end flanges, so that a little uncertainty exists regarding the exact area which ought to be regarded as cooling surface. Accordingly the formula, when applied to large coils, may give a greater rise of temperature than will be indicated on test, while applied to small coils the rise it gives may be somewhat less. It is very usual, when coils stand vertically, to make the cores somewhat larger than the magnets, thus leaving a space all round through which flows upwards by convection a continuous current of air. This reduces the difference of temperature between the top and bottom layers of wire, and if it were possible to wind the coils on a skeleton frame, so that half the heat could be carried off in this way, the difference between the temperature of the hottest wire then in the middle of the coil thickness, and the coolest then on both surfaces, would be reduced to about a half of its previous amount. There are, however, many practical objections to this, and in the absence of further experiment, we must content ourselves with keeping the surface temperature down to the limit of 75° C. already given, knowing that if the coils do not exceed  $2\frac{1}{2}$  to 3 inches in thickness, there is incurred, with the ordinary windings in use, no danger of overheating due to the greater temperature of the bottom layers. Accordingly, for a machine designed to work in an atmosphere of 40° C., the rise of temperature being fixed at 30°, a radiating surface of 11 square centimetres per watt, as indicated by the formula, would be allowed.

As regards armatures, the same reasoning applies. We argue that if the temperature of the surface does not exceed the limit given, no danger is to be apprehended from the greater temperature inside. In calculating the amount of radiating surface to be allowed, the heating due to hysteresis must, of course, be taken into account, as well as that due to the copper resistance of the conductors. For an armature having a peripheral speed of 3,000 feet per minute, and running in an atmosphere of 40° C., the rise of temperature being then 30°, the formula shows that about 7.4 square centimetres per watt are required for radiation, and this is the usual allowance, in practice, for a rise of 30°. If the rise is to be less, a correspondingly greater surface must be allowed. In cylinder machines, both the interior and exterior surfaces are counted as of equal value, the draft of air through the interior making up for the greater heat generated inside relatively to the amount of surface. In drum machines, the exterior surface is taken along with such proportion of the ends as may be considered of value for radiation.

Sometimes the rising of the surface temperature of an armature after the machine has stopped has been attributed to "accumulation of heat," an expression not

very apt in its application to the circumstances. In a long run, the armature must get to a temperature such that the loss of heat is exactly equal to the amount generated, though the time it requires to attain this temperature varies much according to the size and design of the machine. There is, in the proper sense, no accumulation after this point is reached, the rise of temperature after stopping being due to the fact that the capacity for dissipating heat is greatly reduced by the stoppage, that the flow of heat is therefore checked, and that the difference between the temperatures of the inside and outside are consequently diminished, the outside gradually getting hotter, until equilibrium between flow and temperature is established. The immediate effect of stopping is, therefore, to raise the temperature of the surface to something above its running temperature, but something under the temperature of the interior.

In designing machines, the field magnet coils are always made as short as the specified temperature limit will permit, but as regards the armature, conditions other than those having reference to heating may frequently operate to keep the temperature rise small. Generally, machines running at ordinary speeds, attain a temperature approaching the limits given, while running at slow speeds, high efficiency being maintained, the rise in temperature is much less. This means that the conductors in the latter case may have to be made so large to obtain high efficiency, that the temperature rise is considerably under the limit allowable.

If the heat generated in the armature winding, per unit of exposed surface, is to be constant, the current carried must vary as  $d^2$  where  $d$  is the diameter of the conductor. The heat generated by hysteresis having to be got rid of, modifies in practice the application of this rule, as do also other conditions referred to in preceding paragraphs. To show how the currents and sizes of conductors are related in modern machines, the following table is given from the results of practice, the armatures being in all cases Gramme wound.

Ampères.		Size of wire.	No. of layers.
5.0	...	·048" diam. single	... 4
7.5	...	·062" " "	... 3
10.0	...	·075" " "	... 3
20.0	...	·090" " "	... 2
22.5	...	·075" " double	... 2
25.0	...	·065" " triple	... 3
32.5	...	·080" " double	... 2
37.5	...	·126" " single	... 1
40.0	...	·090" " double	... 2
50.0	...	·109" " "	... 2
50.0	...	·148" " single	... 1
60.0	...	·180" " "	... 1
75.0	...	·203" " "	... 1
90.0	...	·238" " "	... 1

It remains to be mentioned that the current density per square centimetre section in the magnet winding of ordinary machines comes out about half the current density in the armature.

(To be continued.)

### M. E. MARES'S ELECTRICAL ENERGY METER.\*

THIS apparatus belongs to the class of watt-hour meters with a periodic discontinuous integration. Fig. 1 enables us to easily understand the principle of its working. It comprises, like all indicators of this class, an apparatus for measuring the power, an apparatus for measuring the time, and a system for integrating the power in relation to the time. The measuring apparatus consists of two fixed bobbins with vertical axes mounted in the general circuit of distribution and a movable bobbin of fine wire placed in derivation at the terminals of the canalisation, the distribution being performed with a potential to all intents constant. The movable

bobbin is influenced from above by the united action of the two fixed bobbins, and the force brought to bear upon it is at each moment equal to the product of the intensity of the current which passes through the fixed bobbins by the intensity of the current passing through the movable bobbin, *i.e.*, to the power,  $E I$ , supplied to the circuit, in virtue of the well-known principle of the watt-meter. This movable bobbin is suspended at the extremity of a horizontal lever, A B, the fulcrum of which is at *b*. Along this lever a carriage moves freely, its weight having been previously determined, and this moves the lever whenever its momentum in relation to the axis, *b*, attains a value equal to the momentum of the electro-dynamic force exercised between the bobbins in relation to the same axis. This carriage moves horizontally, changing its position on the lever, A B, by means of a wheel, M N, toothed on the inner edge of its rim and making one revolution in four minutes, and an inner wheel, O, bearing a number of teeth exactly equal to half that on the wheel, M N. Under these conditions we show kinematically that the point, *m*, describes a straight

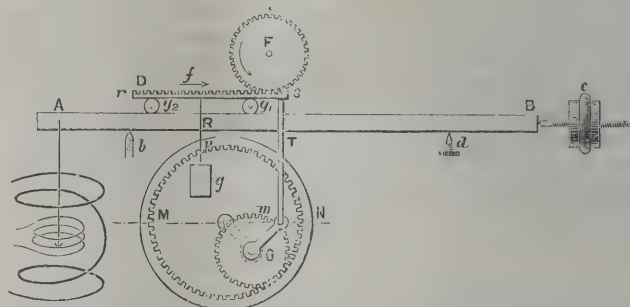


FIG. 1.—PRINCIPLE OF WORKING M. MARES'S METER.

line, which is really the diameter, M N. This horizontal movement to and fro is transmitted to the carriage by the rod, T, which is fixed to it. The position of this carriage is so arranged that its course begins, starting from the extreme left, at the moment when its centre of gravity is exactly over the point, *b*. At this instant, the momentum of the weight is nil, and that of the electro-dynamic force of the bobbins preponderates. The carriage is drawn along from left to right rolling along the lever, A B. On its upper surface is a little rack which turns the first wheel, F, of the integrating dial of the meter in the opposite direction to the hands of a watch until the momentum of the weight in relation to the axis, *b*, exceeds that of the electro-dynamic force in relation to the same axis. The lever then moves at the same time as the carriage, the rack ceases to be in contact with the wheel, F, and its movement is stopped. We can understand that, during the movement, the wheel, F, has turned at an angle proportionate to the path described by the carriage on the lever during the whole of the period that the electro-dynamic action exceeded the force exerted by the weight of the tray; *i.e.*, at an angle proportionate to the power expended by the circuit at the moment when the movement of the lever, A B, is produced. The length of the path described by the tray is arranged so that its maximum displacement will counteract or even overpower the electro-dynamic action corresponding to the maximum power of which the machine is capable.

In order to prevent the hands of the meter from going back during the return movement of the carriage, when the rack would turn the wheel, F, in the opposite direction, the current passing through the movable bobbin of fine wire is cut off during the half period occupied by the return of the carriage to its original position. The momentum of the electro-dynamic action being nil, the lever, A, B, remains at rest on its knife edge, *d*, and keeps the rack away from the wheel, F, during the whole of the period occupied by the return of the carriage. The same thing occurs

\* *L'Electricien*.

periodically every four minutes ; we can easily see that the sum of the angles described by the wheel, F, represents, by a quantity that is almost constant, the electrical energy supplied to the circuit during this period. This constant may easily be made to correspond with the unit, or one of its decimal multiples, by changing

according to M. Marès's instructions by M. Déjardin. The clockwork movement is kept up by the current itself, and the winding up is effected during the half period of two minutes during which the current is cut off in the fine wire bobbin. The winding up is performed by sending in each half revolution five succes-

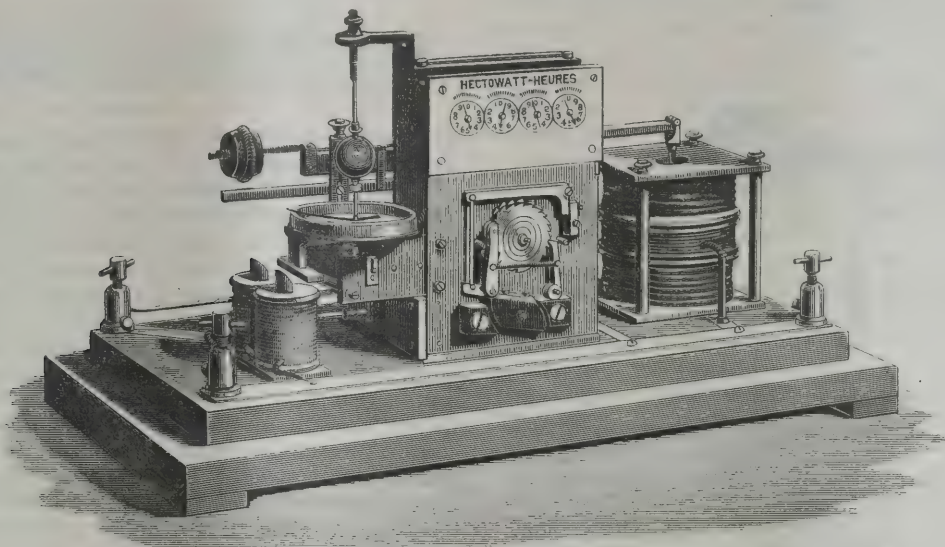


FIG. 2.

Front view of the meter showing the wattmeter, the conical pendulum, the winding mechanism, and the mechanism for stopping the conical pendulum and the integrating dial.

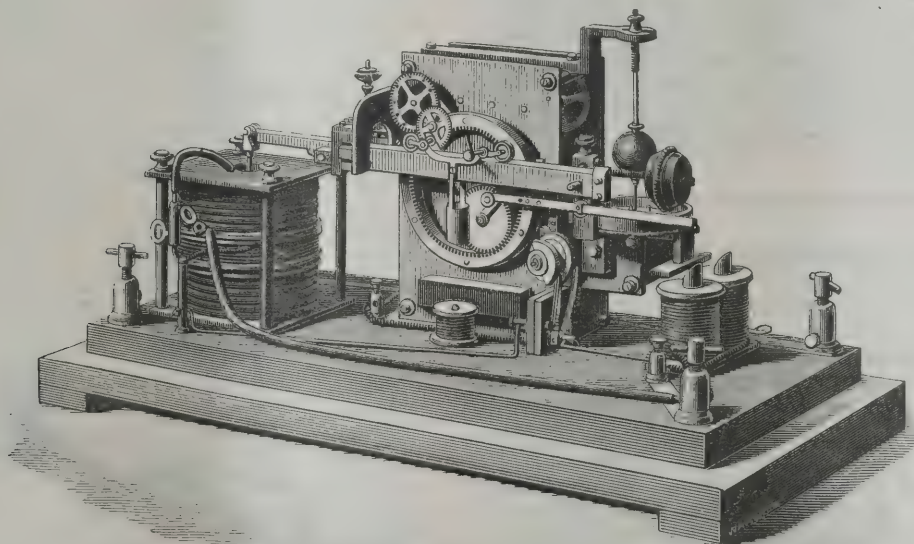


FIG. 3.

Back view of the meter, showing the wattmeter, the lever, and the integrating carriage, the hypo-cycloidal movement of the carriage, and the mechanism for stopping the conical pendulum.

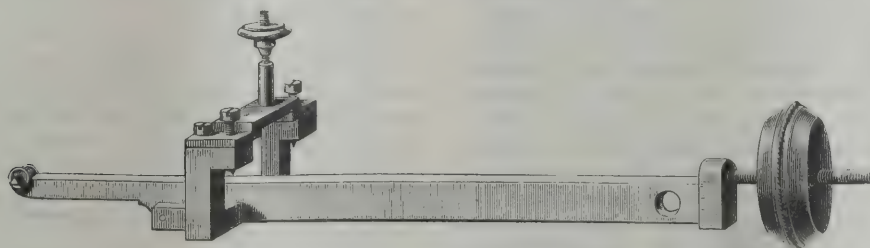


FIG. 4.

the total weight of the carriage, which can be effected with the greatest facility by placing regulating weights, previously accurately determined, in the little bucket, *g*, suspended at the centre of gravity of the carriage. Figs. 2, 3, 4 and 5 show different views of the meter, the principle of working of which we have just described, the mechanism having been constructed

sive currents into the winding electro-magnet (figs. 2 and 3), by means of five friction contacts suitably placed on the principal wheel.

Each of these five currents winds the system up one tooth, and as during a complete period the spring unwinds to the extent of five teeth, it follows that the tension always remains to all intents the same, a condi-

tion which is essentially favourable to the regularity of the clockwork movement, regulated in this case by a conical pendulum, with the object of avoiding all vibration and shaking, the conical pendulum maintaining, by its very principle of action, a movement that is always uniform. This conical pendulum also serves to bring the meter to a level when it is installed, and also when it is put in action.

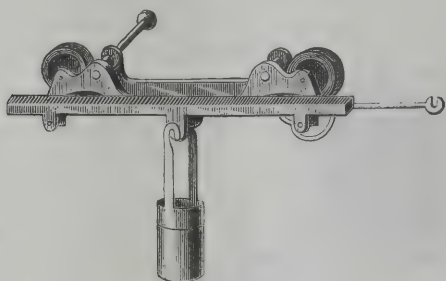


FIG. 5.

An electro-magnet that can be hooked on to the conical pendulum, and which is shown at the left of fig. 2, and at the right of fig. 3, enables the meter to be started at will after each stoppage.

Without dwelling upon the numerous details of construction, which have been most carefully studied both by the inventor and the constructor, we will merely remark that M. Marès's invention constitutes an absolute apparatus in which only those forces are introduced whose values are accurately known. As in the case of Mr. Walker's meter, described in a preceding number, and those which we shall hereafter describe, we will refrain from expressing any opinion on the practical value, if any, of these instruments until the experiments to which they are all to be subjected at the Municipal Electrical Works of the *Halles Centrales* are concluded.

## THE COPENHAGEN CENTRAL STATION.

[FROM A CORRESPONDENT.]

THE Copenhagen central electric light station, concerning the tenders for which a serious misunderstanding arose a short time ago, is to be erected by Messrs. Siemens and Halske for the simultaneous supply of 14,000 glow lamps. The *Elektrotechnische Zeitschrift* states that the work of erection will be commenced early in the spring, so that the station may be completed and ready to start lighting by the beginning of next winter. A site has already been chosen in the Gothesgade, which is situated in the centre of the town, so that the most remote point of distribution will only be 1,300 yards distant. The method of distribution will be the three wire system, which will be so arranged that the loss in E.M.F. between the station and the principal distributing points will be 28 volts, and from the latter to the lamps, 3 volts. The lamps will be of the 110-volt type, and the terminal pressure of the dynamos will therefore have to be 251 volts. The mains will consist of the well-known Siemens armoured cables. The generating station will contain seven tubular boilers of 235 square metres of heating surface, and three compound steam engines which will be coupled direct to six dynamos, each engine driving two machines. The total capacity of the dynamos, which will be of the internal pole type and connected two in series, will be 611 kilowatts.

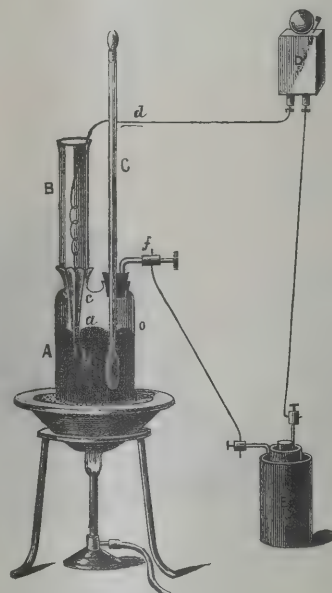
In order to avoid the running in the daytime of any dynamo or dynamos at less than full load, there is to be installed a battery of 272 Tudor accumulators having a discharge capacity of 250 ampères. Future extensions in the output of the station will be effected by increasing the number of accumulators, and for this purpose a four-storeyed building will be erected adjoining the station and capable of containing sufficient

cells to supply 14,000 lamps. In case of a further enlargement being necessary, it is proposed to erect accumulator stations in the suburbs where the cells would be charged direct from dynamos of a higher tension than those to be at first installed.

## A NEW ELECTRICAL APPARATUS FOR DETERMINING MELTING POINTS.

THE apparatus shown in the accompanying sketch is due to the ingenuity of A. C. Christomanos, who gives an elaborate description of it in the *Berichte der Deutschen Chemischen Gesellschaft*. He claims that by means of it a more correct determination of the melting point of substances may be ensured.

The essential features of this apparatus is as follows: The cylindrical vessel, A, which is 12 cm. in height and 6 cm. in diameter, is heated on a sand bath or in an air bath, and is provided with two apertures; a thermometer, C, and a platinum wire, f, pass through a cork fitting into one of the apertures, whilst the other, c, is conical and fluted, and serves for the reception of a drawn out test tube, B. The vessel, A, is filled with pure mercury to such a depth that the end, b, of the test tube is about 2 cm. below the surface, a o, of the metal.



The substance is introduced in a melted condition into the end, b, of the drawn out test tube, so that it forms a layer of from 0.5 to 1.5 cm. in length, and when it has completely solidified again the test tube is placed in position, and the space, a c, immediately above the substance filled with mercury, into which dips the platinum wire, d.

On applying heat, the mercury in A is uniformly heated throughout its whole mass, so that the thermometer and the substance are always at the same temperature; the moment the substance melts the two mercury columns come in contact, the circuit is completed, the bell, D, rings, and the temperature is noted.

**Fire Caused by an Electric Wire.**—The *St. James's Gazette* had on Monday a sensational paragraph as to a fire caused by an electric light wire in the Grand Café, Boulevard des Capucines, Paris, on Saturday night. Shortly after 9 o'clock the lights went out, and a strong odour of burning India-rubber was perceptible. The woodwork in the cellar began to burn, and in a very short time flames appeared from the windows. Before the current was turned off and the fire extinguished considerable damage had been done.

## TELE-PHOTOGRAPHY.

By HENRY SUTTON.

UNDER various names the problem of transmitting optical images by aid of the telegraph wire has at different times had attention drawn to it.

In putting forward something new in this direction, I will begin by inventing a new name, and propose calling the subject Telephany, and the electro-optic instrument the Telephane.

The art of telephony is simple compared with that of telephany. In the former we deal with a consecutive series of waves of varying rate and length, and it is the consecutive character of sound waves that lends itself so admirably to electrical translation.

In telephany we are met, at the outset, with a great preliminary difficulty, having to deal with a surface or plane in which the effect appealing to the brain must be observed in all the varying character at one and the same time.

The problem stands thus : a means has to be devised whereby the varying effects on a plane surface are translated into consecutive series of electrical currents, and by means of the consecutive series of currents reconstruct, so to speak, a copy of the original surface ; that is, we have to take an optical image, seen as a *surface*, translate it into a *line* of consecutive varying electrical currents, and by means of these produce an effect as a *surface*, having the characteristics of the original image.

We have here two images as surfaces having no time value, and a series of electrical currents having a time value, yet these opposing characteristics are to be presented to the brain as a momentary impression.

Before showing how this apparently impossible problem may be handled, I will explain a probable means for electrically transmitting a photograph.

If we make what photo-mechanical operators call a *screen* negative of a portrait, using a coarse screen, and from this a photo-lithographic transfer, transfer it to zinc, and transmit the result by any of the several autographic systems, we have the desired result. In fact, if we apply our knowledge of *half-tone block* making to telegraphy, we are at once in possession of a means of electrically transmitting the photographic semblance of any person.

We may make a *screen* negative, and from that obtain a print on zinc or copper coated with sensitive albumen or bitumen, using the usual solvents, water or turpentine, as the case may be, with which to wash away the unexposed albumen or bitumen, then let the stylus of any autographic system traverse the developed image, the result at the receiving end is a facsimile portrait. I have used the expression *screen negative*, as it is an understood trade name ; as a matter of fact, a *screen positive* would be necessary. We may go further, instead of receiving the facsimile on chemically-prepared paper, as in the Caselli autographic telegraph, we can make the receiving stylus perforate thin paper (with the electric spark) by means of a constantly-working induction coil, but only put into the receiving circuit by the transmitted current. Place this paper on a lithographic stone or zinc plate, pass a roller charged with greasy ink over it, and we have a *printing surface*, the portrait being *transmitted and reproduced for the printer*, photo-electro-mechanically.

But this is not telephany ; the latter must be understood as the means of transmitting images which may be in motion, as seen in a photographic camera, but not in colours.

Having spent some years in studying the problem, I designed the following system five years ago, as my Victorian scientific friends can testify. It may be of much assistance to workers in this direction. I think it offers a fair approximation to the solution of this very difficult problem ; at any rate, if in its present form it is not the actual solution, I feel sure it is in the direction indicated by my method, that the successful accomplishment of telephany will result.

## Transmitter.

L (figs. 1 and 5) is a photographic objective of the rapid type, producing an intensely illuminated aerial image at A A.

D D (figs. 1, 2 and 5), light metal disc revolving at a fixed rate of not less than 650 revolutions per minute under the control of La Cour's phonic wheel and fork apparatus as in the Delany multiplex system.

G (figs. 1, 3 and 5), a glass or other insulating plate, to the front surface of which is held, by binding terminals,  $S_1$  S, two triangular pieces of metal just separated from each other, E E.

C (figs. 1, 3 and 5), a small piece of lamp-black, selenium or other substance, the resistance of which may be varied by heat or light. Lamp-black compressed is probably the most suitable.

The disc, D D, has a series of small holes, 1, 2, 3, 4, 5, 6, 7, 8, perforated in it, and gradually approaching its centre, as a spiral, these holes must be numerous, and yet only one at a time in the field of the image at A A.

R L (figs. 1 and 5) is the most important part of the transmitter. This I term the regulating lens ; it is a lens placed with its plane surface just to receive the aerial image from the objective L, its focal length being such as to bring all rays reaching it through the perforated disc to a point or focus at C, and therefore its function is to introduce them consecutively to the circuit comprised in  $S_1$ , E, C, E, S.

Under the influence of this regulating lens the whole image, A A, is allowed to act in consecutive manner, and therefore vary the resistance of C in accord with the lights and shades of the original. We thus solve the big problem of translating the plane image into a line of consecutively varying strength of current, and by bringing C under the influence of the whole image within one-tenth of a second, and during the same time reconstruct our image at the receiving station, persistence of vision will enable us to see the image as one impression.

## Receiver.

$S_1$  (figs. 4 and 5), any artificial source of light, a beam of which is by means of lens, L, passed through a pair of Nicol prisms, P, A, this beam reaching lens  $M_1$ , is magnified and received by the eye-piece, M, M, and viewed by the eye, E. It is absolutely requisite this beam be received by the eye through optical means. The presence of a translucent screen at X, X, would be fatal, owing to the delicate nature of the desired effect.

D D (fig. 4), is a perforated disc, similar to and revolving synchronously with the disc in transmitter.

K K (figs. 4, 5 and 6), terminals inserted in glass and having a small space between, holding a drop of bisulphide of carbon, S.

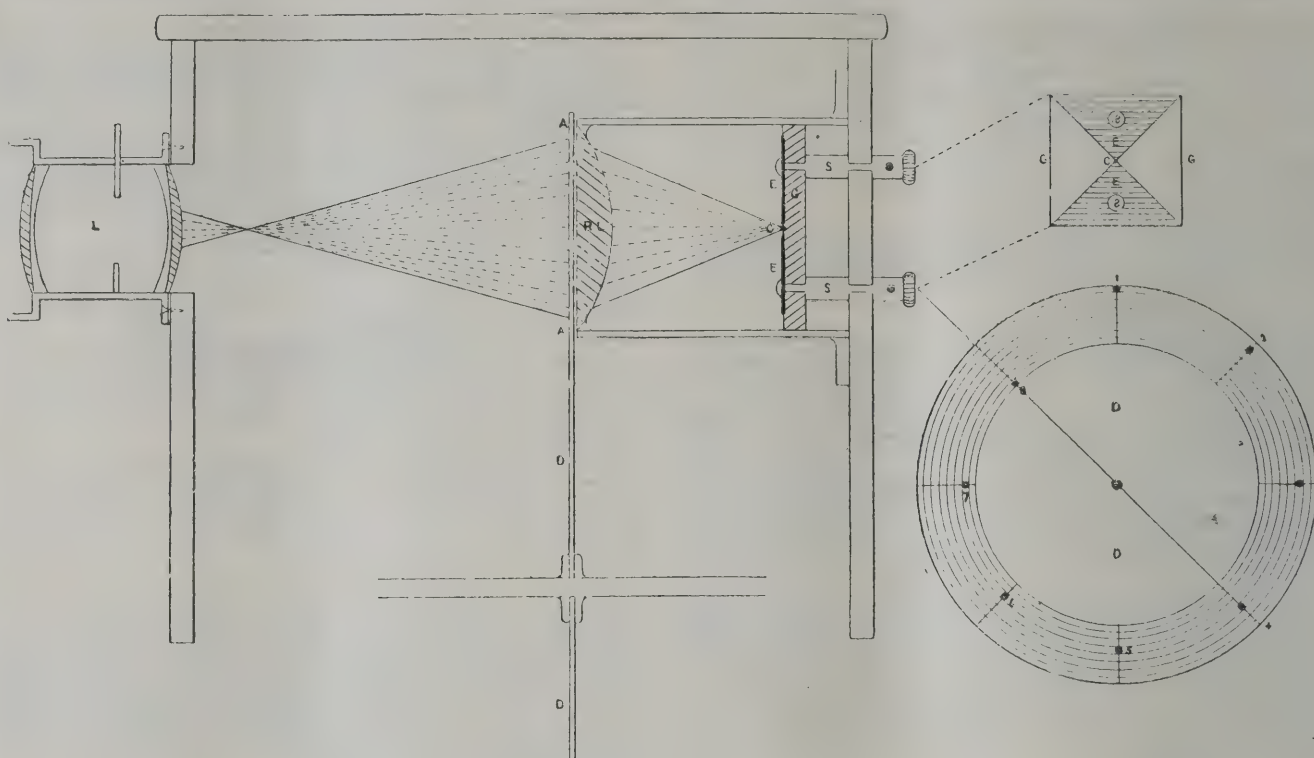
On rotating the Nicol, P,  $45^\circ$ , we reach the position of extinction.

The terminals, K, K, being placed in the secondary circuit of the transmitter—that is, to line—the variable electrostatic strain produced in the drop of bisulphide of carbon under the action of induced currents received from transmitter, is to produce variable rotation of the polarised beam, and, therefore, variable quantities of light reach the eye, E.

It is obvious the varying tints will be seen in similar position as in original image, owing to the synchronous movement of the discs.

The receiver is, then, based on Dr. Kers's discovery of the rotation of a plane polarised beam of light, through electric stress producing a strain in the medium.

There seems to me no question that the electric impulses will do their work within one-tenth of a second, and the point is whether the stress at O O will be sufficient to produce an observable effect, and whether this may be increased by passing the light through a bisulphide of carbon cell having a longer path of, say,  $\frac{1}{16}$  inch diameter, as shown at fig. 6, instead of through the drop of bisulphide ; so that, conceding the telephane is based on a rightly conceived principle, it becomes a



FIGS. 1, 2 AND 3.—TRANSMITTER.

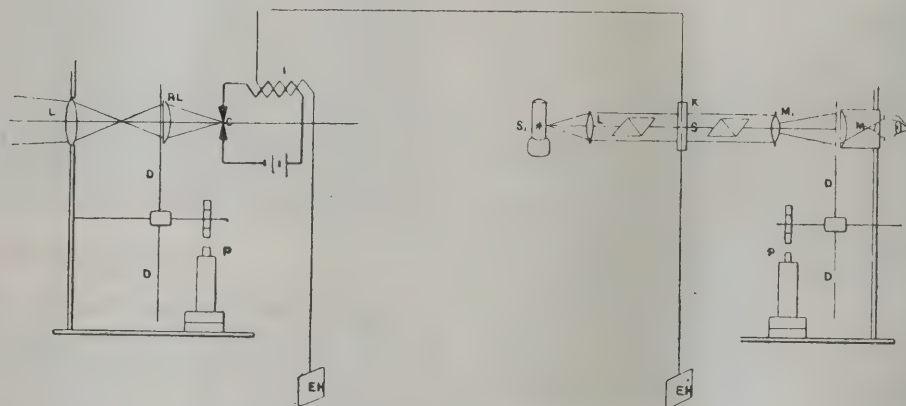
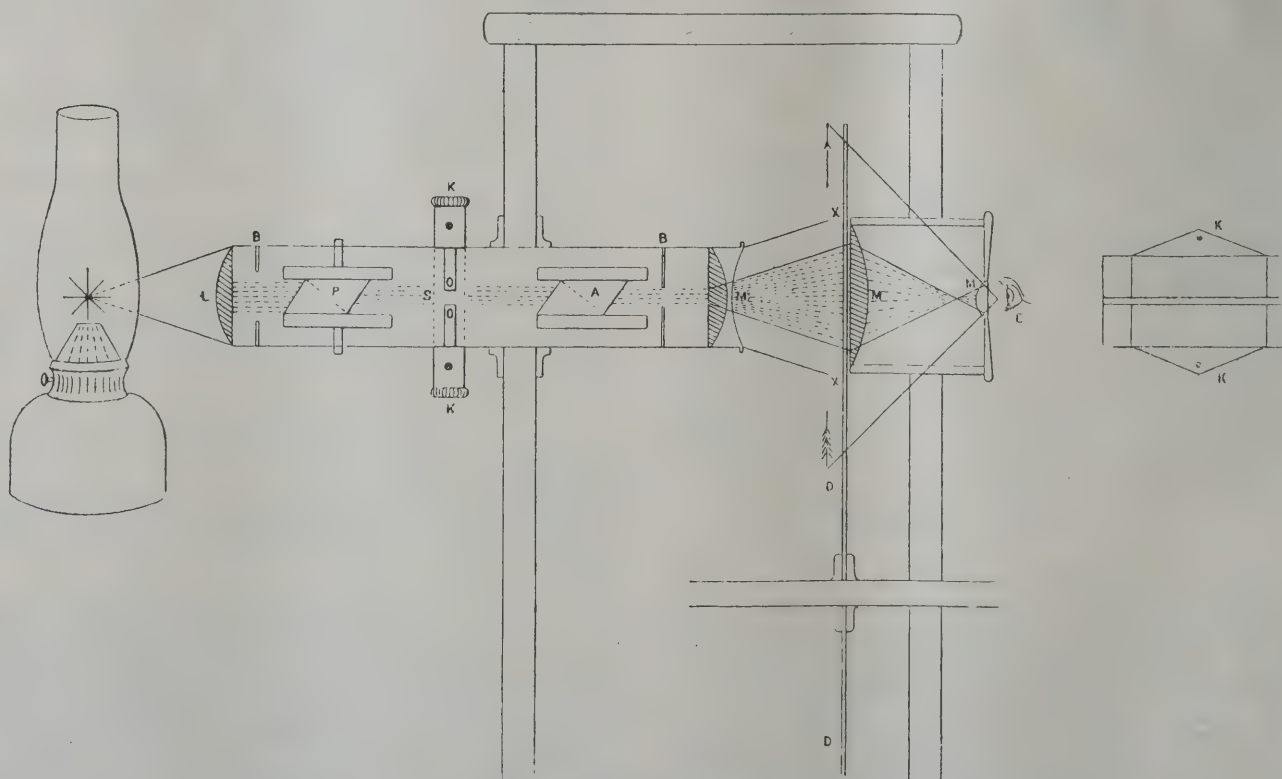


FIG. 5.—ARRANGEMENT OF CIRCUITS.



FIGS. 4 AND 6.—RECEIVER.

question whether the quantitative results of the physical effects utilised in its design are sufficiently great.

I think the transmitter may be considered as near the right thing as the present state of our knowledge will admit us to reach; there is an appearance of finality about it.

With regard to the receiver it is a question of degree; the actual quantity of light required to reach the eye may be very small when received optically; in fact, so small as to have no power of illumination on a translucent screen; but a quantity of light producing no visible effect on any media, when received by means of an eye-piece shows a bright disc. Owing to being away from references, I regret my inability at the moment to give the name of the inventor of the revolving disc; with the exception of these discs the whole design is original, and was devised at Ballarat, Victoria.

## INDUSTRIALISM.\*

By W. B. ESSON.

WHEN the Old Students' Association did me the honour to nominate me as President, I mildly suggested that by way of innovation this address might be dispensed with. The committee received that proposal, however, with open derision. Individually and collectively it smiled while declaring that the suggestion had been made before, annually in fact, and just as often as a president had been nominated. The committee remaining inexorable, the serious business of choosing a subject had to be considered, and I may confess that considerable difficulty was experienced in the selection. One does not want to talk as a specialist on such an occasion, as the address can then interest but a few. One wishes, if possible, to say something in which all the members will feel some interest, notwithstanding the diversity of the pursuits in which they may be severally engaged. And surely there is in their occupations plenty of variety. The Old Students' Association includes among its members men occupying positions in every department of applied science. In the numerous branches of civil and mechanical engineering, in departments devoted to the several applications of electricity, and in most of the great chemical industries we find the Old Students' Association represented. And this, I believe, is common to most of the representatives, that each in his particular sphere strives with might and main to achieve success.

But whatever branch of industry we may be engaged in, at some time or other we have attended the classes for technical instruction, conducted under the auspices of the City and Guilds of London Institute. It may have been for a long or short period at the Central Institution, at the Finsbury Technical College, or in a subterranean chamber in Cowper Street before either of those places was built. Anyhow, the scattered members of this association, with their many diverse interests, are united by the bond of that old studentship and the memories which cling around it. True, we can boast of no ancient pile or venerable quadrangle echoing the voices of the past, but if we are without the historical associations and traditions of an ancient university, we are at least free from its "dead languages and its undying prejudices." We are distinctly with the moderns. We went in for a liberal education, and for such preparation as was rightly or wrongly conceived to best fit us for rising to a place from the ranks of modern industry. Our object was to win, if possible, in the industrial struggle—in short, to make a living.

And here, I think, we touch common ground. We are all engaged in fighting, with more or less success, the battle of life. We are all performing some function in the world of industry. We are all trying to make a living. In endeavouring to find a suitable subject for my address these reflections occurred to me, and it then struck me that I might occupy your attention for a short time with the all-important subject of Industrialism, a topic of vast interest to all classes of the community, since it involves problems the solution of which is becoming pre-eminently the question of the present as it will be that of the future.

Industrialism is a growth, and the present highly specialised methods of production have been evolved gradually from the ruder processes of the past. In savage communities there was no variety of individual occupation. By turn a warrior, a hunter, a fisherman, a tool maker or builder, each lived independently of his neighbour, concerted action only being taken for the purpose of defence. But in time, individuals showed special aptitudes for particular kinds of work. Some displayed special abilities in making weapons, while others, more intrepid and courageous, showed a more decided inclination to use them. In a sort of understanding that the men who made the weapons would be furnished with food by the hunters who used them, we can easily

understand a crude division of labour to have had its origin. From a remote savagery through the ages which elapsed before men began to learn much of the arts of civilisation, the principle of the division of labour continued to develop the skill afterwards directed towards the arts of civilisation, being first engendered and fostered by the arts of war. "If we go back to the Stone Age," says Mr. Herbert Spencer, "we see that the implements of the chase and the implements of war are those showing most labour and dexterity. If we take still-existing human races which were without metals when we found them, we see in their skilfully-wrought stone clubs, as well as in their large war canoes, that the need of defence and attack were the chief stimuli to the cultivation of arts afterwards available for productive purposes. Passing over intermediate stages we may note in comparatively recent stages the same relation. Observe a coat of mail or one of the more highly finished suits of armour—compare it with articles of iron and steel of the same date; and there is evidence that these desires to kill enemies and escape being killed more extreme than any other, have had great effects on those arts of working in metal to which most other arts owe their progress. Indeed, it may be questioned whether in the absence of that exercise of manipulative faculty which the making of weapons originally gave, there would ever have been produced the tools required for developed industry."\* But in addition to fostering industrial art, war slowly brought about the conditions which made an industrial state of society possible. It was by force of arms that small nomadic hordes were welded into large tribes, that tribes were welded into small nations, and that small nations were welded into large nations. Only by the social aggregation arising from warfare were produced the conditions under which the division of labour could be developed to any considerable extent.

Contemporaneously with the development of industry grew the distinction which gradually became more emphasised between the regulating and the regulated classes. In primitive tribes the chiefs worked like other members with their own hands, and were only distinguished from them by more than usual valour exhibited in attack or defence. All fought when the need arose, and the separation of the chief from the rest of the tribe, his ceasing to work with his own hands, his gathering around him warriors distinguished by their valour, his dividing amongst them the lands of conquered races, the rise of feudalism, its ultimate decay and the advent of wage-paid labour were amongst changes which the slow roll of centuries gradually brought about.

Coming to the Middle Ages, we find the arts of civilisation considerably advanced; towns growing and Industrialism advancing as militancy decreased. The oppression of feudal lords pressed hardly, however, on the growing industries, and labour was burdened with heavy taxes to maintain large numbers of military retainers in a state of idleness and comparative luxury. "The old freemen formed their Frith-Gilds against the tyranny of mediæval magnates,"† and to defend themselves against the extortionate demands of lawless barons who were continually waging war against each other and levying the cost of their "expeditions" on the struggling industries. The history of those old-world combinations is extremely interesting reading, but here we have no time to do more than mention their existence; we are only skimming over their history in order that we may more completely realise that the present is unquestionably born of the past.

"So long as the towns were struggling against adversity, all the citizens worked together with public spirit and enterprise to secure their common welfare, but when a town had fully achieved its freedom and began to prosper, the oldest families of traders began to insist on their own privileges as the only proper full citizens and as members of the Town Gild."‡ While it was necessary they welcomed the combination of the craftsman against their common enemies, but as the need for such combination diminished, the aggressiveness they manifested against their inferiors increased. To resist the pretensions of the old burghers, those who worked at different trades accordingly formed themselves into craft-gilds, and for many generations the struggle between the two classes was carried on. But at length the victory was gained by the younger and more vigorous combinations of handicraftsmen. "In one town after another the craft gilds, leaguering together, overthrew the town gilds, and obtained mastery of the town,"§ governing it afterwards in their place for many generations.

In early times comparatively little capital was required for production. Industry was carried on by hand labour, and there was no expensive machinery to purchase and keep in repair. Then, the advantage of gathering many workers under one roof had no existence, and employer and employed were practically on the same level. Each craftsman worked with his own hands and in the same room with his workman, being aided by two or three hired journeymen and an apprentice, who became in course of time a craftsman himself. The relation of master and servant was, in those days, almost patriarchal in its character. The man was brought into close contact with his employer daily and hourly, and the identity of interests was recognised by both, for the class war between capital and labour had not as yet commenced. Again, good work was done in these old days. The gilds took care that only capable craftsmen should be permitted to join their associa-

\* Presidential Address delivered to the Old Students' Association of the City and Guilds of London Institute at Finsbury College, November 6th, 1890.

\* Herbert Spencer, "The Study of Sociology," page 194.

† Brentano's "Introduction to English Gilds," page 195.

‡ Marshall's "Economics of Industry," page 46.

§ *Ibid*, page 46.

tion, and the standard of work was well kept up. They were charitably inclined, and insured the worker and his family against want in case misfortune overtook them. While their influence lasted, the guilds were in many ways useful, but they had their day, and a time came when the attempts to regulate trade, and the various restrictions they imposed on industry, became harmful. Then came a reaction, and the guilds had to go, as have all institutions which lack the power to adapt themselves to a changed condition of existence. They lost their influence; advancing industry would not be restrained in the old grooves, and the guilds refusing to yield, it forthwith burst the barriers they had set up, and moved on in spite of them.

I have said that in early times there was little difference socially between the craftsman and his journeyman. But time brought a change in this respect. The craftsmen prospered, and their savings accumulated; capital began to grow, and the gulf between master and man, which was at first an almost imperceptible fissure, gradually widened. The former had grown rich, and had ceased to work with his own hands, or associate with his workmen. As his wealth grew, he employed more labourers, whom he treated in much the same way as he himself had been treated by the old burghers in former times; and in combining to protect themselves against the aggression of the rising capitalists, the workmen followed the example set by the craft guilds when they resisted the claims of the frith guilds. So we see that there is manifested the same kind of tendency all through the history of industry. Nor is the reason far to seek. While tribes were engaged in constant strife, Industrialism was born [and nursed in the lap of warfare. The arts were cultivated chiefly as a means of defence against the inroads of enemies or of conquering neighbouring tribes. Men were barbarians, and their adaptation to the restraints imposed by their living in the society of others had scarcely begun. Through centuries of warfare, of violence and bloodshed, Industrialism slowly struggled, civilisation progressing painfully and only as fast as savage hordes settled down to peaceful occupations. But though warfare nursed Industrialism, consolidated scattered tribes, and by its discipline converted a savage incapable of continuous application into the man who, as a citizen, works from morn till eve, it left, alas! its bitter traits behind. In early times every member of the tribe was a fighter, and only slowly was the separation at first partial, between soldiers and citizens accomplished. The latter were liable to be called upon for military service, for a long period, and when the separation was complete it was a soldier who had become a citizen. A soldier, inasmuch as he or his ancestors had been trained in cruelty, disciplined in butchery, had been schooled in treachery, and had revelled in bloodshed. And with this inheritance from the past, bearing in mind how slowly human nature changes, and how very gradual has been the process of adaptation to the social condition so far, is it any wonder that citizens should have manifested, though in a less degree, the aggression and the cruelty, and the persecution of former ages? Is it matter for surprise that Industrialism should have displayed to a large extent the character of the militancy from which it was developed?

But we come now to the end of the seventeenth or beginning of the eighteenth century, when began that new era of steam, by which the world has been revolutionised. It was for pumping the water out of mines that Thomas Savery, in 1698, took out his patent for an engine to raise water by fire. I need not describe this engine, which to most of you is probably well known. As a pumping engine it was of course very inefficient, its duty being something less than one-tenth that of a modern one. But there is one thing I would mention here as illustrating the opposition at that time to the introduction of any appliance which appeared to dispend with hand labour or render a less number of workmen necessary. In a letter addressed to the "Gentlemen Adventurers in the Mines of England," Savery apologises, in a measure, for his invention, saying, "As for pump making, that part of the trade will be much improved by my engine, for I must use board and timber for pipes, and have considerable employment for pump makers and carpenters for timber used about my engine. For my design is not in the least to prejudice the artificers, or, indeed, any other sort of people by this invention, which, on the contrary, is intended for the benefit and advantage of mankind in general." This language from an inventor implies the state of feeling at the time with relation to labour-saving devices. In 1712, an improved pumping engine was erected at Wolverhampton, by Newcomen and Cawley, who gave us the beam to be found in the modern type. Following Newcomen, we had Smeaton and others, who made great improvements, but it was left for the genius of Watt to make, from 1769 to 1782, those radical changes which have stamped the great inventor for all time as the father of the modern steam engine. At first, his engine, like previous ones, was used only for mining purposes; but soon he invented his methods of converting the reciprocating motion of the beam into the rotatory motion required for working machinery. For the pump rods were substituted the connecting rod, with its sun and planet wheels; the steam engine was thus rendered applicable to any purpose of industry, and became the greatest power for good—some would say for evil—the world has ever seen.

In the middle of the eighteenth century, the industries of the country were carried on, to a large extent, in the homes of the operatives. In the first stage of cotton manufacture, for example, the weavers, dispersed in cottages throughout the country, wove their webs from yarn spun by their wives and children on the common hand-wheel or distaff. At the same time, the weaver cultivated a small patch of ground, and, to us living midst

the toil and toil of this nineteenth century, the picture of domestic industry and family life, thus presented, is very pleasant to dwell upon. Honest John Ruskin, whose heart in matters of political economy is very much better than his logic, may not be quite alone in lamenting the gradual extermination of those rural workers. But lamentations are worse than useless. The system of those days represented but a phase in the history of industrial development, it disappeared to give place to another, it was but transient as is indeed the system of our own times. Distance is apt to lend here, as elsewhere, enchantment to the view, and it is not unlikely that the workers' lot in those days was, taking all things into consideration, harder than it is now. In 1767 the spinning jenny was invented by Hargraves, and a few years later, Arkwright constructed spinning frames in which were utilised Wyatt's, Paul's and High's inventions for spinning by rollers. To work these new machines water-power was employed, and from this period dates the rise of textile factories. "For several years," says Mr. Redgrave in his report for 1875, "the textile industry was carried on in the rural districts only. . . . Water on the hill sides was irregular in its flow; work was therefore irregular; when the stream was full, work was brisk (we should have called it excessive); when it was dry the factory hands were employed on the lands in haymaking, or other like occupations. Thus the operatives were both farm labourers as well as factory workers; and as manufacturing was not the complicated affair that it is now, they were free from many evils which afterwards arose from the introduction of steam and the immense energy and enterprise of our manufacturers." The application of steam to the working of machinery created the factory system proper. Inventors had not been idle, and numerous improvements had been effected in several directions. Cartwright had invented his power loom in 1784, and in 1785 Boulton and Watt erected in a factory at Papplewick the first steam engine applied as the moving power for spinning machinery. Progress was now rapid, and in every department of industry invention was producing new improvements. The rising seats of industry had been connected with each other and with the sea by canals. Large steam factories were erected, and tempted by higher wages and the promise of constant employment, armies of workmen came to fill them from the rural districts. Capital now became a huge power in industry, and very soon occurred the opening skirmishes of the labour war which has continued ever since.

If we are to believe the writers of this period the miseries following upon the introduction of the factory system were very great. In many cases the capitalists made a bad use of their power. "They crowded their factories with apprentices, many of whom they took from the parish with a premium of £5 each. The factories were so unhealthy, and the children worked so hard and for such long hours, as to be seriously injured physically and morally."\* In the report already referred to, Mr. Redgrave calls attention to the bringing together, without previously providing adequate and proper means for accommodation, hundreds of families to fill the mills. "Then followed immediately the proneness to run the costly machinery, regardless of the waste of human life, health, and happiness for any number of hours that seemed good to the capitalist. The factory population appeared in time to have become a distinct race that was known at a glance, so defined were the effects of overwork and unhealthy dwellings upon the physical appearance and condition of the people." Nor did the moral condition of the workers improve. Improvident and intemperate they appeared to go from bad to worse. Due to higher wages and the correspondingly easier conditions of existence, population increased rapidly. While, in fine, an increase of wealth took place in the capitalist part of the community, increase of numbers took place in the operative part. While gold was coined for the master, children were multiplied for his mills.

At a very early period the State had attempted the regulation of industry. In the time of Edward III. there was enacted a Statute of Labourers which attempted to fix the amount of remuneration each labourer should receive. It was intended to keep wages down, but notwithstanding from 1388 to 1444 they rose from 50 to 100 per cent. In the time of Henry VII. there was a law which directed people at what fairs to sell their goods. In the time of Henry VIII. it was made penal to sell any pins but such as are "double headed and have their head soldered fast to the shank and well smoothed, the shank well shaven, the point well and round-filed and smoothed." During the reign of Edward VI. a statute prescribed that a person making a usurious bargain should be fined £100. In the time of Mary and Elizabeth, laws were made limiting the number of looms each master weaver might have, and stating how many more apprentices than journeymen he might employ. In the reign of James I. a very wise Legislature prescribed the quantity of ale which should be sold for a penny.† Laws fixing the rate of interest and the wages of labour, prescribing the price of food and the shape of wearing apparel, specifying the goods to be made and the method of their manufacture were multiplied. In fact, there was in those days scarcely any limit to the duty undertaken by the State. Nor is this surprising when viewed in the true light of history. The citizens had inherited an unlimited belief in the power of Government. Primitive tribes could only be successful in war as their soldiers obeyed without question the orders of their chiefs. Those tribes in which the subordination was greatest would accordingly

\* Marshall's "Economics of Industry," page 188.

† See Herbert Spencer's "Social Statics," p. 313.

survive, while those in which it was less would in time be weeded out. It was the one necessity of the militant type of society that subordination to the chief should be complete, and faith in him entire. But the general in battle was also ruler during the intervening periods of peace, and to him the people looked to adjust their industrial quarrels, as well as to lead their soldiers to successful battle. Again, "success in war must largely depend on that conformity to the ruler's will which brings men and money when wanted, and adjusts all conduct to his needs."\* Accordingly laws were made just as if industry, like armies, could be governed by force. The discipline of warfare had produced men whose nature it was to submit to control from rulers, and as Industrialism grew gradually out of the old militancy, men's natures changed but slowly in adaptation to the conditions of the newer régime. Somewhere between savagery and civilisation, partly industrial, partly military, society still believes the ruler all powerful. Every day the Government is petitioned to undertake some new work which it is assumed would be impossible of accomplishment by the community without its aid. Government may change its form, but the belief in its omnipotent character remains. Savage chiefs may be displaced by emperors and kings. Kings may delegate their functions to Parliaments. Parliaments may in time give place to Republican assemblies. But all through history the tradition of unlimited power clings to the rulers, nor will it disappear until man is completely adapted to the social state, and the last sign of militancy shall have disappeared.

I have said that workers became demoralised under the factory system, and appeared to go from bad to worse. Accordingly, the Legislature undertook to set things straight. In 1802 was passed the first factory Act proper, which directed that "the rooms should be washed well with lime and water twice a year; that apprentices should be clothed with two suits yearly, and should be instructed in reading, writing, and arithmetic the first four years; that the hours of work should not be more than 12 per day, exclusive of meals, and that work might be carried on by night in mills with 1,500 spindles." The rapid development of the steam engine changed the conditions of labour in a short time to such an extent that the Act was no longer applicable, and so, in 1819 and 1825, we have further Acts restricting the hours of labour and the work of children. It may be mentioned that in the textile industries the apprenticeship system had by this time disappeared, as the skill requisite for handling the improved machinery could be attained in a very short time. These Acts were followed in 1831 and 1833 by further Acts relating to textile industries, but in 1834 the Legislature extended its scope, and passed laws influencing other classes of operatives. Accordingly, we had soon Acts of all kinds for the regulation of mines and collieries, print works, bleaching and dye works, bakehouses, copper and iron works, machine shops, fish curing and fruit preserving. In fact, there are so many Acts, that no one knows very well where we stand, and a Factory Enquiry Commission has had to acknowledge that this branch of our laws has become very unwieldy, and wants unification.† That these several enactments made the life of the workers somewhat easier for a time may be true. But that they have produced any true and lasting good, except in so far as they have removed hindrances to the natural growth of Industrialism, the student of sociology is at liberty to doubt. And there seemed to be some such doubt in the minds of the workmen themselves, for trades unions, formed at first to petition Parliament to pass measures in their behalf soon found that the aid they required was not forthcoming, and that they would have to "rely as the guilds before them had relied, upon their own energies. They no longer approached the Government with the purpose of inducing it to interfere in their behalf; but they petitioned and agitated for the cessation of Government interference against them."‡ The conduct of the trades unions in the early part of the century was reprehensible in the extreme, and the opposition they manifested towards the introduction of machinery is a matter of history. It may indeed be doubted if working men have yet been intellectually convinced of the benefit of machinery. Anyway they had not been convinced in those days, and labour disputes were oftentimes accompanied by riots and bloodshed. By numerous Acts it had been made a crime punishable by fine and imprisonment to refuse to work for the purpose of obtaining higher wages, and "men who know they are criminals by the mere object they have in view, care little for the additional criminality involved in the means they adopt." However, trades unions have become more sensible, and one by one the combination laws have been repealed. The Legislature now recognises the combination of workmen for the purpose of bettering their condition as perfectly legal, provided that in carrying out their ends nothing is done by the combination which would be declared against law if done by an individual. The trades unions of to-day are in many ways analogous to the craft guilds of the past. They have for their objects, says Mr. Howell—(1) "to procure for their members the best return for their labour in the shape of higher wages, shorter hours of labour, and the enforcement of certain restrictions as to the condition of employment which could not be accomplished except by means of combination; (2) to provide mutual assurance for the members by means of pecuniary assistance in the case of sickness, accident, death, out of work, superan-

nuation when disabled by old age, loss of tools by fire, and emigration.\* These are principles with which no fault can be found, but, that they are often very superior to the conduct they are supposed to guide is a matter of everyday observation.

Well, gentlemen, these remarks bring me to modern times. Time has allowed me to notice only a few of the more important factors in the evolution of Industrialism. The growth of railways, the development of steam navigation, improvements in agriculture, electric telegraphs and submarine telegraphy, have each made enormous contributions to our industrial progress. But these by no means exhaust the list. It has been said that we of the nineteenth century are intellectually the heirs of all the ages, and not less true is it that present day Industrialism inherits a huge legacy from bygone centuries, has grown up by infinitesimal contributions of far away ages, as well as by the larger contributions of recent times. My history has been of a somewhat sketchy character, and the more so, perhaps, as here and there the narrative has been broken in the endeavour to emphasise the method of science in history. To thinking men, history is no longer a record of this or that sovereign's deeds, a chronicle of court intrigue or gossip of princely trappings. But it is the story of a nation's progress. It tells how institutions arise, flourish, and in time decay as new ones take their place. It shows how each successive stage of development arises from the one immediately preceding and gives birth to the one immediately following it. It recognises that the evolution of society proceeds in accordance with law, and that causation, though partially concealed by the extraordinary complexity of the phenomena to which it relates, must have here, as in all development, universal dominion. And so, as I have said previously, Industrialism is a growth, and the present methods of production have been evolved from the processes of the past. We have now huge factories employing thousands of workmen, and filled with self-acting machinery in which the division of labour is carried to the utmost limit. Whereas, in times past, it was necessary to spend years in serving an apprenticeship and learning several branches of a trade, in a great many instances the old apprenticeship system has been done away with, the whole of a lad's attention when he enters the factory being engaged in watching the one operation performed by an automatic machine. In all branches of the finished metal trades we are struck by the clever combinations of mechanism employed in the performance of the several operations, and as we watch machines rapidly doing their work with unerring precision, and requiring almost no attention, we may well wonder whether economy in production can go much further, whether adjustment of acts to ends can be rendered by mechanism more perfect. In the engineering trades similar division of labour is found and similar specialisation is apparent, though probably to a less extent. When I was an apprentice the old-fashioned millwright was not extinct. He was a man who could "put his hand to anything," as the saying is. He had served seven years' apprenticeship and could make his own patterns, forge whatever he needed, do turning and filing, and, on a pinch, might attempt brass-founding with metal melted over a smith's fire. He was a veritable Jack of all Trades, but he is no more. Modern industry does not require him and draws the line very distinctly between the several branches of the engineering trades. We have smiths who work forging machines and hydraulic press tools. We have turners, planers, slotters, shapers, drillers, millers and special tool men, each of whom has under his charge an expensive self-acting machine tool which it is his duty to look after and which it should be his aim to thoroughly understand. As Mr. Nasmyth says, "All that the mechanic has to do, and which any lad is able to do, is not to labour but to watch the beautiful functions of the machine."† In the shipbuilding trades the tendency towards specialisation is not less marked. In short, in every branch of industry the aim is twofold; first, to do as much as possible by machinery because hand labour is expensive; secondly, to restrict the function of the workman to performing one operation or to looking after one machine, because his whole thought being then concentrated on one thing, he soon acquires in his work special dexterity. The effect of the division of labour on the workman, when carried to excess, need not be here considered. On that point opinion is divided, some believing that constant employment, without variety, deadens a man's mental activity and resource, while others equally capable of judging hold that concentration on one operation sharpens a man's intelligence so far as concerns the sphere of his work, and gives him more opportunity for thought on subjects unconnected with his employment. However that may be, the division of labour is a great fact in modern industry, and as a means to economical production, there can be no question about its efficacy. The tendency is to carry it farther and farther, as concerns, by getting larger, are enabled to take the fullest advantage of the benefit it confers. It is the condition of production which Industrialism has by its natural development brought about.

But along with improved methods of production there has grown up within the century that vast distributive system which is represented by a railway capital of nearly one thousand millions sterling, and the direct employment of nearly half a million workmen. When we remember that these have to be fed, and clothed and housed; when we recollect that a large

\* Herbert Spencer, "The Man v. The State," p. 109.

† G. Phillips Bevan, "The Industrial Classes and Industrial Statistics." Textiles and Clothing, page 221.

‡ Marshall's "Economics of Industry," page 189.

\* "The Conflicts of Capital and Labour," by George Howell, chap. III, section 45.

† Tenth Report of the Trades Union Commissioners, 1868, page 65.

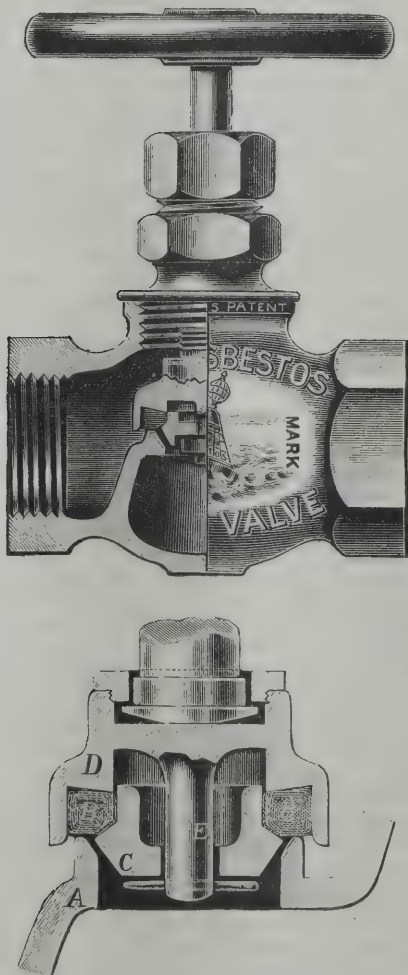
number of workmen must be employed in providing the iron and steel required in the manufacture of rolling stock, and that materials and labour must be constantly forthcoming for the construction of lines in progress; when we perceive that this distributive system, rendered necessary by increased production, has in its turn stimulated production to an incalculable extent, we begin to realise, though but faintly, how far-reaching in its influence on industry railway progress has been. Then we have—as constituting a farther means of distribution—docks, in the construction of which millions have been expended, and a huge mercantile navy which, by the direct and indirect employment of armies of workmen, enable us to effect an advantageous exchange of our goods for those of other nations. Ships have to be built, and workmen have to be supplied with the means of life in return for their labour. The raw materials must be furnished, and the necessary iron and steel produced by another host of labourers. Nor is this all, for outside the artisan classes indirectly depending on distribution for a livelihood, are thousands employed in mercantile houses, shipping agencies, and brokers' offices, all occupied in effecting the distribution of commodities, not to speak of the hundreds of thousands engaged in wholesale warehouses and retail shops. Meditating on these things, I say we begin to comprehend now vast, how complex, how inter-dependent in all its ramifications Industrialism has become.

(To be continued.)

### A NEW ASBESTOS-FACED VALVE.

WE venture to think the valve we illustrate will meet a long-felt want by supplying a flexible seating which can be renewed, if necessary, in a few minutes, by an ordinary workman at a cost of a few pence, and for which no special tools are required.

The lettered section and description we give will, we hope, enable its advantages to be clearly defined.



A represents the form of seat adopted in this valve which, in addition to the ordinary angled seat, has a round edge to prevent damage to the packing ring, B, when the latter is brought into contact with it.

D is a loose valve, actuated in the ordinary manner by a screwed spindle working in gland of the valve top, which, when first set down, brings the packing ring, B,

on to the seat, A, and for ordinary pressures a perfectly tight and elastic joint is thus made, but, by setting the loose valve, D, hard down, the sliding cone, C, comes into contact with the angle of the seat, A, and being free on the guide stud, E, is forced into the chamber of the loose valve, D, and by compressing the packing ring, B, prevents it becoming damaged.

While the packing ring, B, is thoroughly protected by the lower projection of the loose valve, D, there is little tendency for B to become damaged by the passage of steam or water through the valve, but should it even become entirely washed out, a tight metal to metal seating is the result by A, C and D being brought closely together.

It is claimed that the valve through its elastic seating is not affected either by grit, dirt, expansion, contraction or uneven seating which makes it alike suitable for the highest or lowest pressures of steam, hydraulic, or general water valves by the insertion of packing rings made of the most suitable material to meet the various uses.

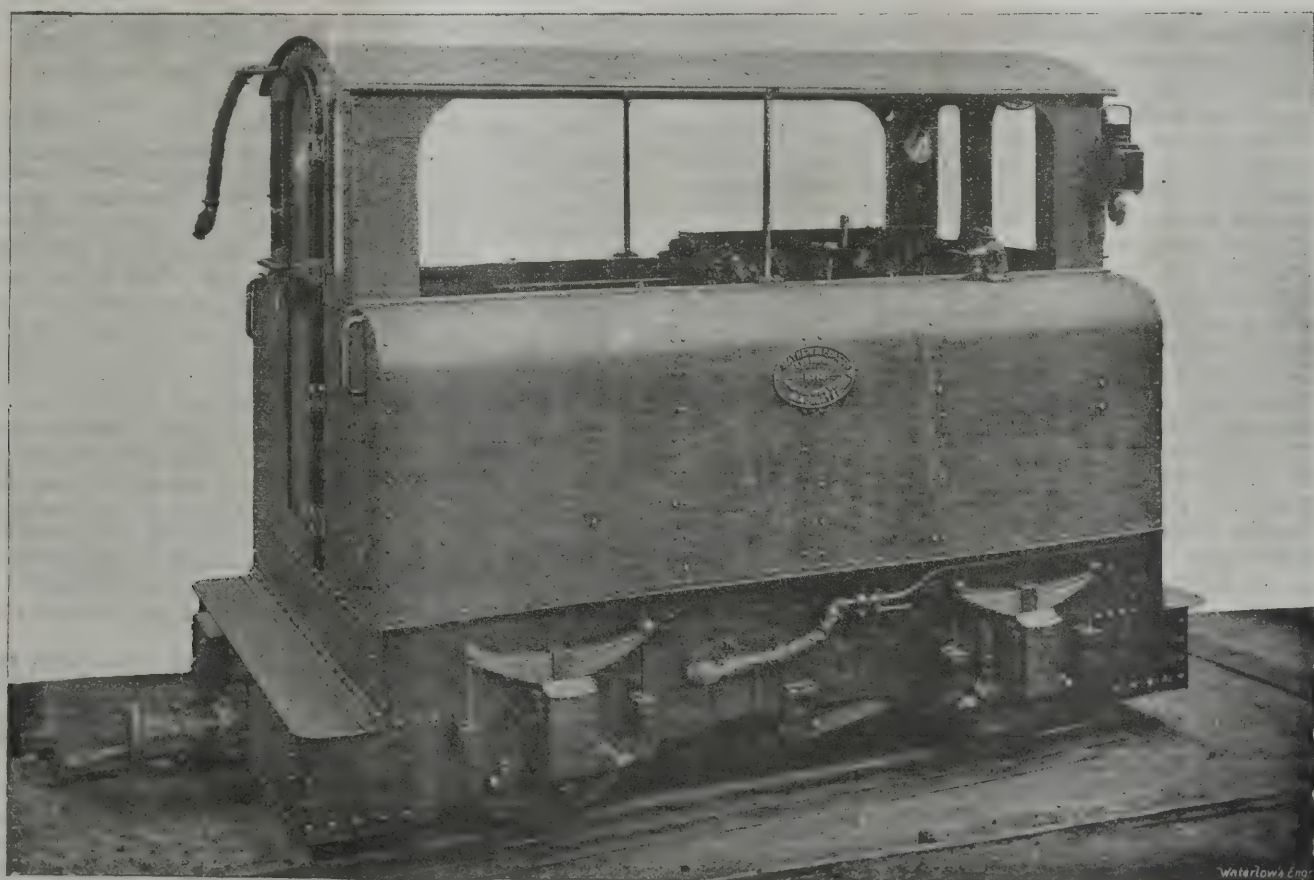
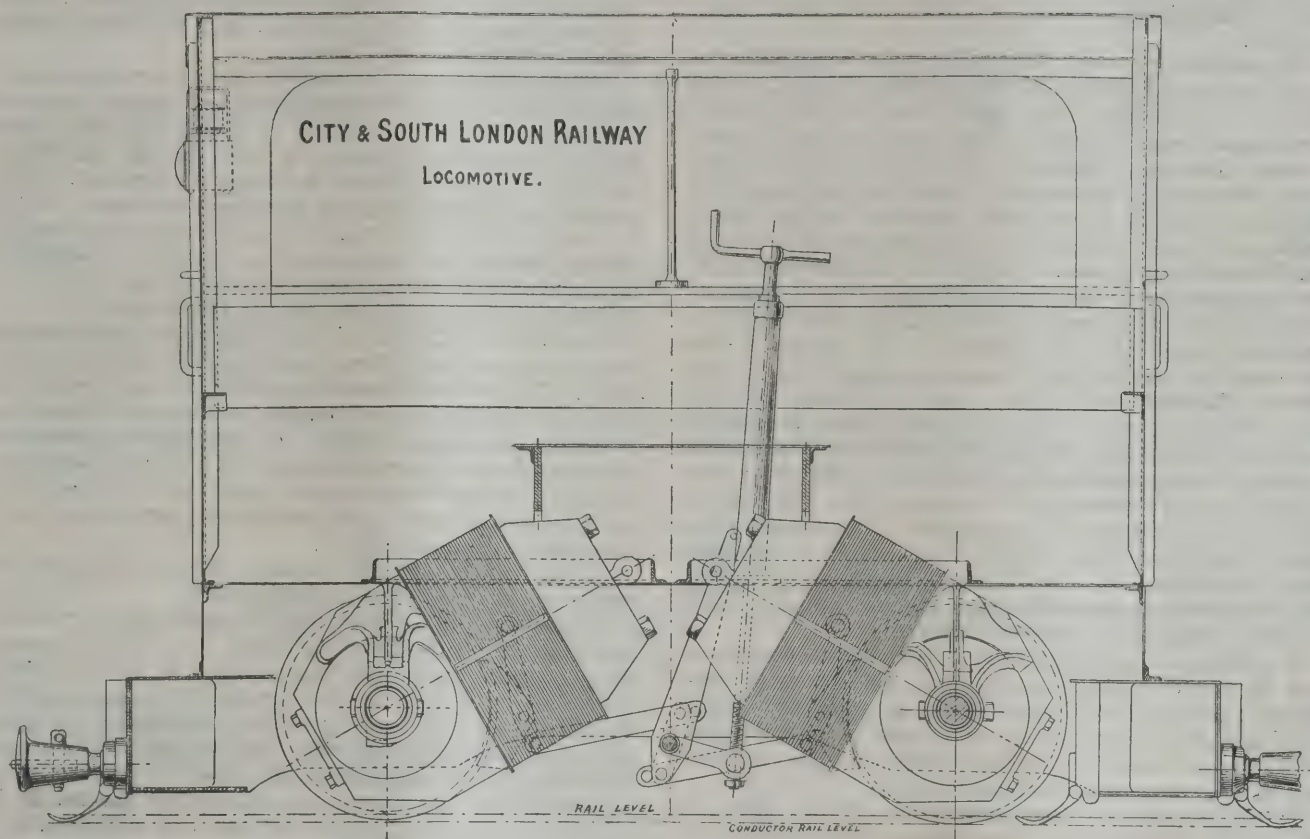
A  $1\frac{1}{2}$  inch valve, made under this patent, is said to have been under test for three months at a steam pressure of 100 lbs. per square inch and found to hold perfectly tight, after which it was put under hydraulic test, and by being lightly screwed down held a pressure of 2,240 lbs. per square inch.

The packing ring used for these trials was made up specially in asbestos, and is still in perfect order, and we are assured it has not been removed at any time during or since the above trials.

### THE CITY AND SOUTH LONDON RAILWAY.

THIS railway is a subway about  $3\frac{1}{4}$  miles in length, passing from a point in King William Street, City, under the Thames, and on to Stockwell, and constructed on a novel method, designed by Mr. Greathead, M.I.C.E., in the form of two circular iron tunnels 10 feet in diameter, driven throughout the London clay, about 60 feet below the surface, and at a cost of about £220,000 per mile.

The two tunnels, after having passed under the bed of the Thames, have been executed by the compressed air system, in the face of a subterranean difficulty which could hardly be exceeded—namely, a powerful underground river percolating through a gravel bed of large flints and coarse pebbles. This water-flow was kept back for weeks upon weeks by the sheer force of volumes of compressed air, whilst concrete and cement-grout were poured in front of the tunnel shield, and an artificial rock extemporised, in which the segments of the iron tunnel tube could be bolted together. For these and other engineering operations involved the just merit due to the resident engineer, Mr. Mott, should not be withheld. It is well further to note that the tunnels have been driven with exceeding accuracy and unrivalled speed. They were made in 400 yards lengths, 200 yards being driven from each face, and meeting like lengths driven from other faces. The extreme divergence of the junctions amounted in one instance only to seven-eighths of an inch, the others not exceeding a quarter of an inch, although the datum levels had to be transferred from the bottom of the shafts, which now contain the lifts, to the centres of the lines of tunnel, as the shafts were all on one side or the other of the line of railway. The rate of excavation was often as much as 16 feet per day, the average of the working days being 13 feet 6 inches advance of heading. All the anxieties of the engineering work are over, the rails of the road are laid, the platforms erected, and the neatly constructed underground stations, with their walls lined with white



VIEW OF LOCOMOTIVE.

glazed tiles, are ready for the passengers, and have a cleaner and brighter aspect than any of the other underground stations in London. Moreover, they will not be sullied with smoke and dirt from steam locomotives.

The scheme to work this railway by electricity to avoid the use of steam and its noxious results, or the use of rope traction with slow speed and other disadvantages, was submitted to the City and South London Railway Company by Messrs. Mather and Platt, engineers, Manchester. The company accepted the idea, which is entirely original in its main features, though based upon the experience obtained by Dr. Edward Hopkinson, a partner of the above firm, in the construction of the Bessbrook and Newry narrow-gauge electrical railway in Ireland, fully described in previous issues of the REVIEW. The contract for the carrying out of the whole scheme, designed by Messrs. Mather and Platt, was committed to that firm, who employed Messrs. John Fowler & Co., of Leeds, to supply the boilers and engines to work the dynamos for generating the current of electricity; also Messrs. Beyer, Peacock and Co. to construct the framework of their electrical locomotives. The whole electrical plant has been carried out under the special superintendence of Dr. Edward Hopkinson, F.R.S., who has acted throughout as consulting engineer, with Mr. G. A. Grindle as resident engineer.

A number of small tramways, both on the continent and in the United Kingdom, have been worked electrically, and in the United States many of the street tramways are worked in this way, but it has not hitherto been applied on any large scale to the working of a railway of the usual gauge for passengers.

The following are the particulars of the plan of Messrs. Mather and Platt, and details of various parts of the work:—

The whole of the machinery for generating the electrical current is situated at Stockwell, the suburban terminus of the line. At this point a complete plant has been erected for the generation of the electrical current. There are three large generator dynamos of the Edison-Hopkinson type, each worked independently by a vertical compound engine, designed and constructed by Messrs. John Fowler & Co.

The engines work at a steam pressure of 140 lbs. per square inch, and have been built of exceptionally massive proportions. They run at 100 revolutions per minute, giving a piston speed of 450 feet per minute. They are fitted with automatic expansion gear of improved type on both the high and low pressure cylinders, and are controlled by a powerful governor, which is driven direct from the crank-shaft by cotton ropes, the automatic gear being so arranged as to cut off the steam if necessary in both cylinders from dead cut-off to three-quarters of stroke. The engines will indicate up to 375 horse-power each. The cylinders are steam-jacketed, the high-pressure is 17 inches diameter, and the low-pressure 27 inches. The pistons are fitted with Mather and Platt's rings and springs; the valves are specially fitted with multiple ports, which reduces their movement considerably, and still gives a very prompt action. As the parts are as close as possible to the end of each cylinder, the loss of pressure by wire drawing is very small. The flywheels are 14 feet diameter and 28 inches broad, and drive the dynamos direct by means of leather chain-belts 26 inches wide.

The engines are supplied with steam from six Lancashire boilers, 7 feet diameter by 23 feet long, which are fitted with Vicar's mechanical stokers. Two large feed water heaters are also supplied, with brass tubes of ample surface, for receiving the whole of the exhaust steam from the engine without back pressure.

The generator dynamos are of the Edison-Hopkinson patent type, with bar armatures, fitted with all the latest patented improvements of Messrs. Mather and Platt. The weight of the armature alone is about 2 tons, and the weight of the entire machine something over 17 tons. Each machine is capable of generating 450 volts and 450 ampères. The commutators are of

hard copper insulated with mica, and there are three brushes on each rocking arm, each separately adjustable, with bring-forward thrust and hold-off catch. The magnet limbs are exceedingly massive, each limb, with its pole piece, being over 4 tons, and the yoke of the machine weighs about 3 tons.

The machine can be run as shunt, or compound only, as required. The total weight of copper wire on the magnet of each machine is nearly  $1\frac{1}{2}$  tons. The Edison-Hopkinson dynamo is well known as being perhaps the most efficient machine constructed. The present machines have an electrical efficiency of 96 per cent., or slightly over, and the measured efficiency of the engine and dynamo, *i.e.*, ratio of the electric power available outside the dynamo to the indicated horse-power of the engine, is over 75 per cent.

Sir William Thomson's multicellular electrostatic voltmeters are used for measuring the electromotive force. The current from the dynamos is conveyed to a general distributing and testing switchboard, fixed in a recess of the engine house. From this board the main circuits are taken to various parts of the line, and the current passing through each circuit is measured, and suitable arrangements are provided for switching over from one circuit to another.

A plan of the engine house is shown, and also an elevation of the engines and dynamos.

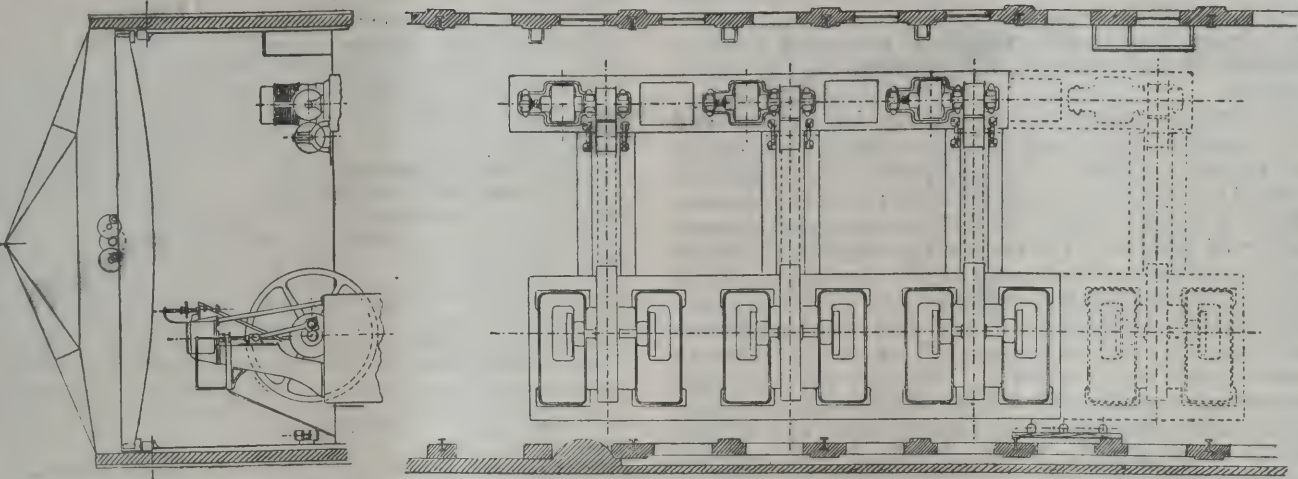
The site occupied is a plot of about two or three acres on the surface, or ground, level. The access between this dépôt and the subway is by a curved tunnel descending from above ground by a steep incline of 1 in  $3\frac{1}{2}$  feet. Up and down this the trains are brought or lowered by a rope and winding engine. This short bit of tunnel is remarkable. Formed on a horizontal radius of 250 feet and a severe vertical radius, it is marvellous that the junction of the two drivings, one from below and the other from above, should have met centre for centre and level for level within an inch or two. At the dépôt the carriage shed is large enough to contain six trains side by side.

The main cables have been manufactured by the Fowler-Waring Company, of North Woolwich, and consist of a copper core of 61/14 B.W.G., insulated with Fowler-Waring patent insulating material, and lead-sheathed.

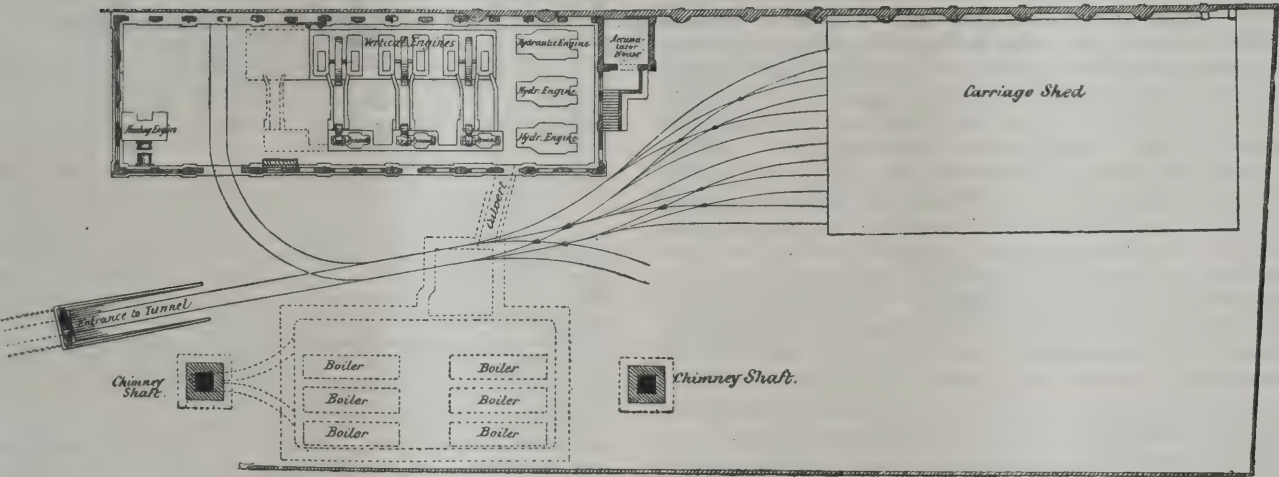
The working conductor is of channel steel, carried on glass insulators, the joints being fished, and also connected with copper strips. The general arrangement of the working conductor is exactly the same as that employed by Dr. Edward Hopkinson on the Bessbrook and Newry line. The steel employed is of very high conductivity, and has been rolled specially for the purpose by the Shelton Iron and Steel Company, of Stoke-on-Trent. The working conductor is divided into sections for convenience of testing and carrying out repairs on the permanent way. The insulation obtained is extraordinarily high. When the full pressure of 500 volts is on the complete system of working and feeding conductors, the leakage current does not exceed one ampère, so that the total loss by leakage is less than 1 horse-power; this is a small fraction of 1 per cent. of the total power required for working the line to its full capacity. The current is collected from the working conductor by sliding shoes of iron or steel arranged in a very similar way to that employed on the Bessbrook line.

Fourteen 10-ton electric locomotives have been supplied by Messrs. Mather and Platt for working the line, each capable of developing 100 effective horse-power and of running up to 25 or 26 miles per hour. The armatures of the locomotives are constructed so that the shaft of the armature is the axle of the locomotive, in this way all intermediate gear and all reciprocating parts are entirely obviated. The method was suggested by the late Sir William Siemens some years ago, but has not as yet been employed elsewhere. A motor is fitted on each axle, the axles not being coupled, but working quite independently. The current is conveyed from the collecting shoes through an ampèremeter to a regulating switch, then to a reversing switch, thence to the magnets and back through the framework of the

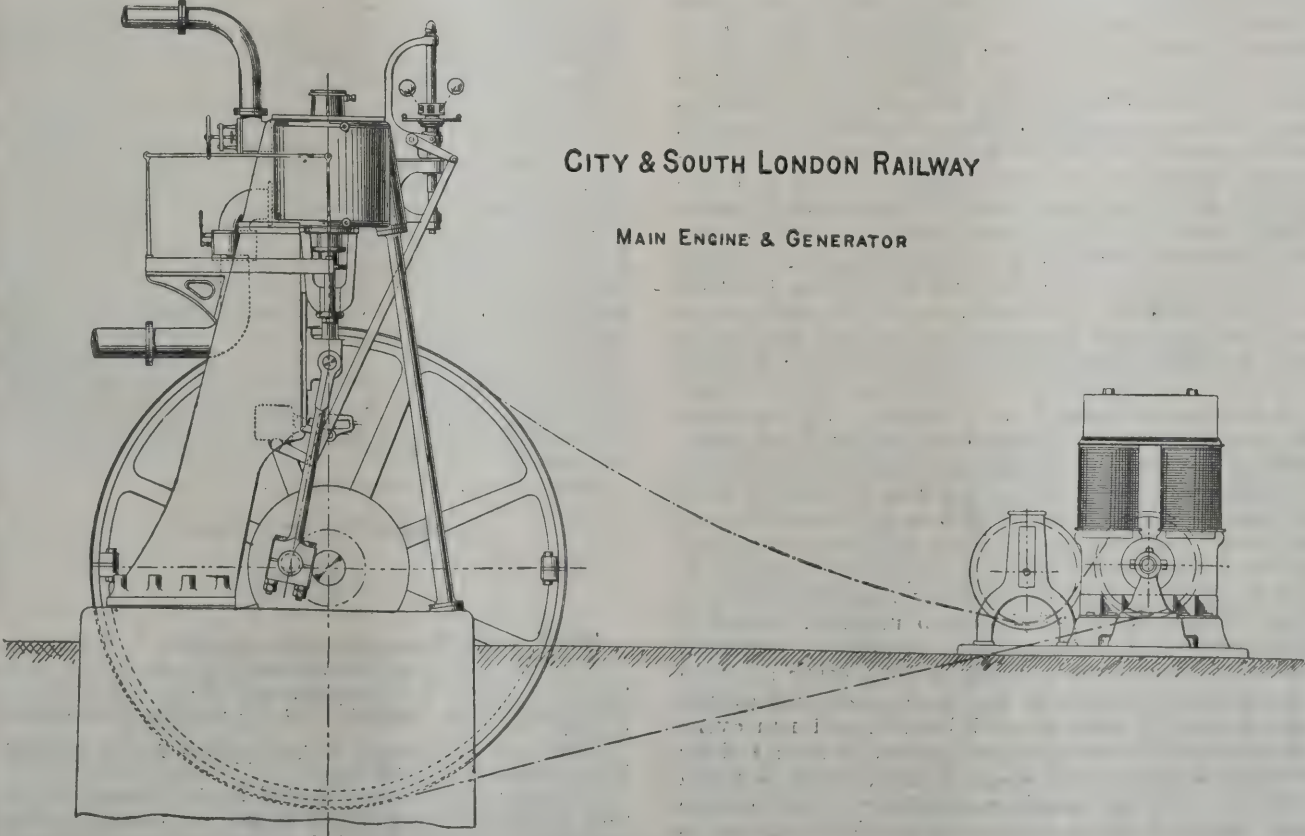
CITY & SOUTH LONDON RAILWAY  
DYNAMO HOUSE



CITY & SOUTH LONDON RAILWAY  
GENERAL PLAN OF GENERATING STATION



CITY & SOUTH LONDON RAILWAY  
MAIN ENGINE & GENERATOR



locomotive to the rails, so completing the electrical circuit. The locomotives are fitted with a Westinghouse automatic air brake and also a screw hand brake, and they are lighted from the working conductor. The train, when loaded, will weigh 30 tons, and it is intended that ten trains shall be worked on the line at one time.

A train consists of an electric locomotive and three passenger carriages 32 feet in length from end to end of the footboard. The long passenger carriages are pivoted on two four-wheeled bogies; and the interior, which is divided by a door in the centre, contains seating for 34 persons. The enclosed portion is 28 feet in length, the external overhang of the carriage platform being coupled up to the similar overhang of the adjoining carriage, and thus forming two open platforms between the three carriages. Upon each of these a guard travels with the train. These guards' platforms are protected at the sides by iron lattice sliding doors. The carriages are lighted by electric light, the current for the lamps being, in like manner, taken off from the conductor.

Each train carries its own reservoir of compressed air, sufficient for 40 stoppages, and as it arrives at the dépôt station of the line, recharges its air supply. The trains are also fitted with hand brakes, the stopping power being thus completely independent of the motive power. Block signalling has been adopted. Should, by any failure of the engine at the dépôt, or any other cause, the train be brought to a standstill, passengers could leave the tunnel safely, as a passage 2 feet wide is provided, clear of the rails, and at no point could the distance to be traversed exceed three-eighths of a mile.

In the generating house is the hydraulic machinery for supplying power to the lifts at the various stations. The cylinder of the ram is 2 feet in diameter, and the wrought iron flange-jointed pipes, which convey the water at a pressure of 1,200 lbs. on the square inch, are nearly a foot in external diameter. The engines which pump the water into them act automatically, being put in motion as the accumulator descends by loss of water at the lifts. At the end of this building is a locomotive repairing shop, with special appliances for lifting out or replacing the dynamos on the locomotives.

The arrangements along the whole line for public traffic are well advanced, but will, probably, not be completed for some weeks yet. The City terminus is in King William Street; the other stations are Great Dover Street (Borough), the Elephant and Castle, Kennington Horns and Oval, and Stockwell. The lifts at all five are of the same type, namely, semi-circular in form, and carry 50 persons at a time. Two such lifts work in the same shaft 25 feet in diameter. No tickets will be issued at booking offices, but passengers entering from the roadways will pay their money and pass through turnstiles, going down by the lift or by stairs at their option. At the outset, when the subway was begun, rather more than three years ago, it was thought to start the running of the line as between the City and the Elephant and Castle, but as the engineering work proceeded, the directors thought that section too small for remunerative commercial working; and obtained an Act to continue the subway to Stockwell, with powers to extend it to Clapham. The carriages are all alike-cushioned and comfortably fitted, there being no distinction into classes. The charge, too, will be uniform, twopence being the fare for the whole or any part of the distance. For the numbers of business men, clerks, and *employés* coming daily into the City it will be a great boon to be conveyed at a speed of at least 12 miles an hour, the journey from Stockwell to King William Street occupying 15 minutes, instead of three-quarters of an hour as at present by omnibus. Ultimately, the trains will follow each other at three minutes intervals, but at the commencement of the traffic they will start about 7.30 a.m., and run every five minutes. The stations are lighted by gas; and for the water supply of the steam boilers, which is taken from the water company's mains, there are two large tanks, one of 12,000 and the other of 25,000 gallons, as a reserve.

## LONDON COUNTY COUNCIL.

THE ordinary weekly meeting of the council was held on Tuesday, with Sir John Lubbock in the chair.

The report of the Highways Committee stated that the committee have considered an application by Mr. H. C. Godfray, on behalf of the North Metropolitan Tramways Company, for the consent of the council to the use by the company, for a period of seven years, of electrical power on its tramways between the Swan public house, Upper Clapton, and the terminus at Moorgate Street, by way of Upper and Lower Clapton Roads, Mare Street, Hackney Road, Old Street, and City Road. Section 4 of the Company's Act of 1890 authorises the use, subject to the consent of the council as the local authority, and of the Board of Trade, of electrical power on the company's tramways or any part thereof, and the Board has power to make bye-laws for the safety of the public and the proper regulation of the traffic. The system proposed to be adopted has been for the last 12 months in operation on the company's lines in Barking Road, outside the County of London; and the committee, having fully considered the matter, are of opinion that, subject to certain conditions, the consent of the council may be given to the use of electrical power on the lines referred to in the application. They therefore recommend:—

That the council do consent to the use by the North Metropolitan Tramways Company, for a period of seven years, of electrical power on its tramways between the Swan public house, Upper Clapton, and the terminus at Moorgate Street, upon condition that previously to such use the company shall put the said lines of tramways into thoroughly good condition, to the satisfaction of the council, and shall undertake to adopt such precautions as the council may from time to time require to be taken for the prevention of injury to the public from the batteries and other machinery of the cars to be used on the tramways.

The Kensington and Knightsbridge Electric Lighting Company has given a notice, dated October 22nd, 1890 (registered No. 126), of an intended extension of mains in Palace Gate (1 plan). There seems to be no objection to this, and the committee recommend—

That the sanction of the council be given to the works referred to in the notice (registered No. 126), dated 22nd. October, 1890, of the Kensington and Knightsbridge Electric Lighting Company.

A notice (registered No. 127), dated October 22nd, 1890, has been received from the Electricity Supply Corporation, Limited, of proposed works in the Strand and Bedford Street (1 plan); but since the date of this notice the company has intimated its intention to serve a further notice with reference to works over a larger area, and that it does not wish to proceed under the first notice. In these circumstances the committee recommend—

That the council do formally disapprove of the works referred to in the notice (registered No. 127) of the Electricity Supply Corporation, dated October 22nd, 1890.

The Westminster Electric Supply Corporation has submitted a plan of the culverts proposed to be used for the company's mains where they cross the carriage-ways. The committee are of opinion that the proposed culvert would, with a slight modification suggested by the council's engineer, be satisfactory, and they recommend—

That, subject to the modification suggested by the council's engineer, the council do approve the plan, submitted by the Westminster Electric Supply Corporation, of culverts to be used for mains where crossing the carriage-ways.

The report of the Parliamentary Committee said, with reference to overhead wires, that on the 21st October the council instructed us, in conference with the Building Act Committee, to give such notices as might be necessary to enable the council to introduce a Bill, or clauses in a Bill, to prohibit or regulate sky signs; and on the 28th instant the council passed a resolution directing that the Bill of last session relating to overhead wires, in the form in which it passed the Select Committee of the House of Commons, subject, however, to such modifications as we might consider necessary, should be again introduced into Parliament next session, and it was referred to us to give the requisite notices, and to take the other measures necessary for the purpose. We have considered as to the manner in which these two matters can best be submitted to the consideration of Parliament, and we are of opinion that they may very properly be included in the same measure, to be introduced as a private bill. We have accordingly given instructions to the agents to prepare the gazette notices and bill, and we recommend—

That the course taken be approved.

## LEGAL.

### Halifax and Bermuda Cable Company v. Magniac.—

This was an action to recover £3,968 and interest, balance of calls due on debentures of the company applied for by the defendant, which was tried on Tuesday before Mr. Justice Charles, without a jury.

Mr. Crump, Q.C., and Mr. Spokes appeared for the plaintiffs; Mr. Haughton for the defendant.

Mr. CRUMP said defendant applied for 50 debentures of £100 each, in May, 1889, and 49 were allotted him; he paid £500 on application and another £500 on allotment, but, applications for the balance being unattended to, after some difficulty an action

was commenced by substituted service, the defendant, being abroad, and judgment was signed against him. Afterwards, on the application of the defendant, the judgment was set aside, and a defence was put in to the effect that he had been induced to apply for the debentures by misrepresentation.

Mr. HAUGHTON said he need not trouble his friend to go into the case at length. The defendant had satisfied himself that the prospectus was issued *bonâ fide*, and negotiations had been going on with a view to his paying the whole amount due, and the company abandoning any claim for costs, which he understood was agreed to; but when the friend who had conducted the negotiations said he should like to have the debentures on paying over the money, it appeared that these very debentures which had been allotted to Mr. Magniac, and on the footing of which he was sued, had been deposited by the company as security for a loan, and the parties with whom they were pledged declined to release them on payment of the amount due on the calls, their claim being somewhat larger on account of interest. He asked, therefore, not making any objection to paying the amount, and even the costs, that the money might be paid into court or deposited with someone who would hand it over on receiving the debentures.

Mr. CRUMP said his friend was quite mistaken. When the defendant paid the money the debentures would be handed to him.

Mr. HAUGHTON asked leave to prove what he had stated, but

Mr. Justice CHARLES said such an issue was not raised on the pleadings. He must accept Mr. Crump's statement, and, as the only defence raised was abandoned, he must give judgment for the plaintiffs.

**Edison Electric Light Company v. Robertson.**—(Chancery Division.)—This was an action to restrain the defendant from further infringing the plaintiff's patents, for delivery up of the infringing lamps, and for costs.

Counsel for the plaintiffs moved for judgment in default of appearance for the defendant, and

His lordship made an order giving effect to the statement of claim.

## THE BRITISH INSULATED WIRE COMPANY.

UNDER this title a company has been formed for the purpose of working in this country the patents of the Norwich Insulated Wire Company of America, by which wires are insulated with paper. Mr. R. E. Crompton is the consulting engineer, which should be a guarantee that the processes, whatever they may be, are of value. The prospectus, however, does not furnish such information as would convince an expert that a really good thing has been produced; there is not one word that would indicate that if the insulated wire were submitted to the action of damp, or if soaked in water, its insulation would remain unimpaired. We are told that in New York the wire has been submitted to *the most searching test* of being laid close to the Steam Heating Company's mains. To call this a searching test is the height of absurdity; there are plenty of cables that will stand heat. Again, the electrical inspector of the Corporation of Liverpool is convinced that the cable is a good one—because it maintains a high insulation at a high temperature. As well might it be urged that the telegraph lines in India preserve their insulation in spite of the heat of the climate. Taking several other reports, we find that practically nothing more definite is stated than that the reporter "is convinced that the cables and wires are of a very superior kind." There is apparently no attempt to make any test which the merest tyro in a submarine cable factory would know to be necessary. We do not mean to condemn the wire; it may be a very good article both as regards efficiency and cheapness, but the practice (so common) of attracting the unsuspecting public by reports which are not worth the paper they are written on, cannot be too severely condemned.

**Siemens and Halske.**—A Vienna correspondent, under date of October 30th, informs us that the Anglo Bank is negotiating for the taking over of the electrical establishments which the Berlin firm of Siemens and Halske owns at Vienna, as well as the electric railway at Pesth belonging to that firm.

## NOTES.

**Croydon and the Electric Light.**—Mr. W. H. Preece, F.R.S., who has been consulted with reference to the introduction of the electric light into Croydon, which has been determined upon, has submitted an elaborate report, in which he states that it would be easy to establish a central station at the waterworks at the back of the Corporation offices, and from thence to generate and distribute sufficient electrical energy to serve the whole of the district. He proposes to replace the whole of 1,781 gas lamps by electricity. The provisional order which is to be applied for will include the whole borough; but it will only be compulsory to supply at first a fixed area, being the central portion of the town.

**The Electric Light at Southampton.**—The Southampton Electric Light and Power Company are now busily employed in laying their cables between the works in the Back-of-the-Walls and the Royal Southampton Yacht Club.

**Theatre Lighting in Bologna.**—The Brunetti Theatre, in Bologna, is now lighted by electricity. The prefectoral authorities, in order to ensure the safety of the public, informed the proprietors that they must either erect an iron curtain for the stage, or adopt the electric light, the latter alternative being eventually chosen. The plant comprises a steam engine and boiler of 14 N.H.P., and a compound Tecnomasio dynamo, running at 1,100 revolutions, with an output of 100 ampères at 100 volts. In addition to the glow lamps, the auditorium is lighted by three 10-ampère arc lamps, whilst a fourth arc is placed at the theatre entrance.

**Electric Lighting of the Guildhall.**—The Guildhall will be lighted by electricity for the first time on the occasion of the Lord Mayor's banquet on the 10th.

**Electric Lighting at Taunton.**—A gas contemporary calls attention to the fact that the electric lamps are having games. One evening last week the street arcs were out for about half an hour, and during the past two months the light has failed some half dozen times. Perhaps our electrical friends of this town may enlighten us on the subject.

**Theatre Lighting.**—Mr. Wilson Barrett will dispense with gas altogether behind the scenes of his new theatre, and use electric light.

**The Electric Light Area in Edinburgh.**—The compulsory area has been marked out, and the notices adjusted, in connection with the application for a provisional order.

**Harrogate Electric Lighting.**—It was decided at the last meeting of the Town Council to apply for a provisional order.

**Electric Lighting in Cardiff.**—The Council has decided to oppose all applications of private companies for lighting the town by electricity. It is proposed to keep it in its own hands, and land for this purpose will be purchased shortly.

**Electric Lighting at Brighton.**—On Tuesday, the Mayor of Brighton (Alderman Manwaring), laid the foundation stone of the Corporation electric generating station in North Road, Brighton. The Mayor expressed a hope that years to come would prove the wisdom of the decision of the Town Council. He was not prepared to say that at the first starting of the electric light installation it was going to be a financial success; but in the time to come, he thought they would find it was one of the wisest steps the Town Council had taken.

**Electric Light and Diving.**—On Monday last Mr. Applegarth exhibited, at 39, Queen Street, City, a greatly improved diving apparatus fitted with an incandescent lamp in the helmet. The object of the improvements is to reduce to a minimum the number of loose pieces completing the helmet, resulting in the saving of time and reduction of risk.

**Electrical Engineering Corporation.**—This corporation has just issued a remodelled and combined form of the catalogue hitherto published by the firms of J. G. Statter & Co., Limited, and their London agents, the United Electrical Engineering Company, Limited, owing to the interests of the two companies becoming one by the recently effected amalgamation of the two concerns. The manufactures of the company cover a wide range in electrical engineering, and the catalogue will be found very complete in regard to both descriptive matter and prices.

**W. T. Henley's Telegraph Works Company.**—A new price list has just been brought out by this company of electric light cables, and wires in vulcanised and unvulcanised India-rubber.

**Long Distance Telephony.**—A long distance telephone line is to be put in operation towards the end of the year between Coblenz and Cologne. A new telephone line between Vienna and Brünn was opened on the 1st inst. The wires are of bronze, and private subscribers in Vienna are able to communicate direct with those in Brünn.

**Newall High-Speed Engine.**—Messrs. G. Wailes and Co. give notice that they are manufacturing the above with improvements which give remarkably increased efficiency. The engine will in future be known as the Lord-Newall high-speed engine. It is made high-pressure, compound triple expansion, quadruple, and launch.

**Kingston-on-Thames Electric Lighting.**—The Board of Trade will be petitioned for a provisional order by the Local Authorities.

**Explosion in Junction Boxes.**—An accumulation of gas in a junction box in one of the principal thoroughfares in Newcastle caused an explosion last Thursday. Three or four persons were knocked down, but no one was seriously hurt.

**Subways for Pipes and Mains.**—A proposal has emanated from the Strand District Board to introduce a Bill into Parliament dealing with the subject of subways for electric light mains.

**M. Secretan.**—A financial contemporary writes:—"To have secured M. Eugene Secretan as manager is a great stroke for Elmore's French Patent Copper Depositing Company. Despite his misfortunes, M. Secretan's name is still one to conjure with, for there is no doubt that he knows copper in all its branches. But we would warn the directors and shareholders against being too greatly impressed by the fact that M. Secretan is a 'firm believer in the Elmore process,' and by his belief that 'the scope for the operations of the company is far more extensive than they had originally calculated upon.' The magnitude of his ideas is a rock on which M. Secretan has foundered before. At the same time he is a very valuable acquisition, and when the company does get seriously to work, of which there is now a prospect, no doubt he may in a practical capacity to some extent retrieve the reputation and fortunes shattered by the collapse of the last copper enterprise, in which he was 'a firm believer.'" To this we might add, that the man who was responsible for the liquidation of a *Comptoir d'Escompte*, ought to find his position on an Elmore Copper Company easy work.

**French Elmore.**—The following appeared in the *Echo* of Tuesday:—"We have no doubt but that the directors of the French Elmore Copper Company are acting in the interests of their shareholders in sanctioning an issue of £50,000 of debentures in order to carry out the views of M. Secretan. It certainly appears as though this discovery as to the inadequacy of the working capital might have been made a few weeks sooner; but, be this as it may, we think the shareholders might naturally expect the board to raise the required sum at *something* under  $7\frac{3}{4}$  per cent. The money is to be raised by the issue of £50,000 debenture stock at par, redeemable on November 1st, 1893, at 105. Thus, in addition to the high rate of interest (6 per cent.), £5 per cent. is to be paid at the end of three years, or an extra £1 13s. 4d. per annum. "Your directors have much pleasure in announcing that the patent company, Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, has offered to supply the amount required by subscribing for £50,000 six per cent. debenture stock at par, redeemable at £105 on the 1st November, 1893." In other words, the directors consider themselves lucky to be able to raise the money at the rate of £7 13s. 4d. per cent. upon a first mortgage security. Instead of "having much pleasure" in making this announcement, we should have fancied that, to pay so high a rate upon so good a security, was a subject for extreme regret. This rate, indeed, is a very serious reflection upon the security, as the opinion of no lenders can be more valuable than that of the parent company. They, more than anyone, know the nature of the security; and it is not, therefore, a compliment to it that  $7\frac{3}{4}$  per cent. is demanded. Of course there may be reasons unknown to us why the offer of the parent company should be accepted, and, provided the shareholders of the French Elmore Company are willing to pay it, no one else has a right to complain. It merely strikes us, as onlookers in the interests of the public, that if the money be required, it might be raised at something under this high rate. From the merits and prospects of the French Elmore Company, and from M. Secretan's opinions, we should have expected that even seven per cent. preference shares could have been issued at par, and redeemable in 1895; instead of which, *over*  $7\frac{1}{2}$  per cent. is being paid upon a debenture security.

**New Insulating Wire Cleat.**—The illustration will fully convey to our readers the novelty and utility of the new "celluvert" or kartavert fibre insulating cleat, now being introduced into this country by Messrs. David Moseley and Sons, of Ardwick, Manchester. It is largely used in America for telegraph, telephone,



electric light, and electric bell *inside* wiring, and answers the purpose admirably, as it is very handy, strong, light, and cheap. Unlike other cleats or staples, it cannot be shattered by an ill-directed blow of a workman's hammer when fastening down with nails or tacks. They are made for single or double wires, but it will be seen that by cutting the double cleat across it will answer for one wire.

**Semaphore Telegraphs.**—In our next we shall be able to illustrate, thanks to the kindness of a friend, a semaphore telegraph, such as a correspondent in our last issue desired to see.

**Provisional Orders.**—The towns of Hexham and Heckmondwike are applying for orders.

**Electrical Trades' Section.**—A meeting of the committee will be held at Botolph House, on Monday, at 4 p.m., when various subjects will be brought forward for discussion.

**Coloured Insulators.**—The overhead lines of the Belgian telegraph and telephone systems follow, in a very great number of cases, unfrequented roads and by-ways where supervision is, naturally, not very close. The wilful destruction of porcelain insulators on these lines assumed such proportions that the Government has been obliged to seriously consider the question of preserving them. A special insulator, protected with a shield of galvanised cast iron, was devised, but it was found that these insulators were far too heavy, and their cost too great; they were therefore abandoned. It would seem that the brilliantly white colour of the porcelain insulators formed the chief attraction to mischievously inclined persons who, unable to resist these fatally conspicuous objects, converted the insulators into impromptu targets. Experiments were consequently made with porcelain of various colours, and a greyish-brown was finally decided upon. Several hundred insulators, coloured in this shade by means of a silicate mixed with the enamel on the surface of the porcelain, were ordered, and were set up alternately with white porcelain insulators. The results of a year's trial showed that out of 102 insulators of each kind (white and coloured) on a line of 22 kilometres in length, 25 ordinary insulators were broken, while only 13 of the coloured ones had been damaged. It was in consequence decided that wherever a white insulator was found to have been wilfully destroyed, a coloured one should be set up in its place, and should this, in its turn be broken, a metal-protected one would be substituted.

**The Spanish-African Cables.**—In commenting upon the failure of the first invitations to tender for the proposed cables between the Spanish settlements on the Mediterranean coast of Morocco, the *Ciencia Eléctrica*, of Madrid, in a recent issue, contained an article strongly condemning the Spanish Administration for its procedure. It pointed out that the conditions laid down by the Administration were utterly impracticable, and that the fact of only two tenders being received confirmed this argument, the more so since neither of the tenders complied with the stipulations of the decree. The Administration was severely blamed, in the first place, for having fixed the price to be paid for the cable at far too low a figure, and, secondly, for not having accepted one or other of the tenders, which after all did not greatly exceed the stipulated figure; nor did these offers ask for conditions at all detrimental to Spanish interests; on the contrary, the compensations asked for in other directions might actually prove advantageous to the country. The disappointment felt in Spain at the failure to secure these long desired telegraphic communications seems to have been very keen, and a perfect storm of indignation appears to have been aroused, perhaps unjustly, against the Administration.

**The ss. "Silvertown."**—News has been received that this cable ship passed Rio de Janeiro on November 4th and reported "all well."

**Personal.**—Mr. Magnus Volk having completed the fitting out of the fleet of electric launches on the river Thames, belonging to the General Electric Power and Traction Company (late Messrs. Immisch & Co.), his connection with the company has terminated, and he is now completing some new types of electrical measuring instruments which are said to possess many novel features.

**The First Atlantic Cable.**—Mr. F. C. Webb, of 27, Forest Road, Dalston, N.E., has published a chart which gives the longitudinal sections of H.M.S. *Agamemnon* and the United States frigate *Niagara*, and the position of the coils of cable, with the lengths in nautical miles, used on the expedition of 1858, when the first Atlantic cable was laid. We understand it may be obtained from Mr. Potters, the agent for the Admiralty charts, Poultry, E.C.

**The Institution of Electrical Engineers.**—On Thursday, November 13th, 1890, there will be a Council meeting at 7 p.m., and an ordinary general meeting at 8 p.m., when the following paper will be read: "On the Chemistry of Secondary Cells," by Prof. W. E. Ayrton, F.R.S., Vice-President; C. G. Lamb, B.Sc.; and E. W. Smith, associates. The above paper will be discussed together with that on "The Working Efficiency of Secondary Cells," by the same authors, which was read at the Edinburgh meeting on July 16th.

**More Newspaper Science.**—The *Daily Telegraph*, on Tuesday, devoted a column to an article on the City and South London Railway. The following is an excellent specimen of the whole:—"Not only does Electra run on messages for us with the very speed of the obedient Puck, who at his fairy lord's command was ready and willing to 'put a girdle round about the earth in 40 minutes,' but she bravely submits to be 'accumulated' and stored up in darkness until such time as we desire light, and then we switch her on, and she leaps into the crystal vacuum and glows with cheerful splendour as she circles round the tiny film of platinum. She is not too proud to ring a bell if required, and if needs be is prepared to carry our very voices through the roar and din of the city, so that man can talk to his fellow at a distance, or minute by minute unfolds on the clicking tape the passing events of all the earth; indeed, like the German school of metaphysics, she almost fairly succeeds in abolishing time and space even as 'forms of the understanding.' Swifter than Iris, the messenger of the gods, our gentle handmaiden has never shirked any task entrusted to her; and if, perhaps, she naturally bungled a bit when set to do the ugly work of a public executioner, her growing stern sense of duty and devotion to mankind may in time steady her hand as the ultimate minister of the death-sentence. Meanwhile, it is pleasant and comforting to record that under Royal auspices she will make her *début* in London this week as an underground traveller."

**Award.**—A gold medal has been awarded to Messrs. Lacombe & Co. for their carbon exhibit in the French electrical section of the Edinburgh Exhibition.

**St. Pancras Electric Light.**—The ceremony of laying the first stone of a central station in Stanhope Street took place on Tuesday last. After the formal business Prof. Henry Robinson (the electrical engineer to the vestry) made a statement as to the work they intended to do. At Stanhope Street the central station plant would be capable of supplying low tension current to serve 10,000 incandescent lamps of 16 C.P. simultaneously, and at the same time high tension current to serve 90 10-ampère arc lamps. There would be nine low tension and two high tension dynamos, one of each serving as reserve. We understand that orders have been received for all the available current on this station. Great energy has been displayed by the vestry committee, and we heartily wish them success in their undertaking.

**Ship Lighting.**—Last week there was launched from the shipbuilding yard of Messrs. Barclay, Earle & Co., Limited, Whiteinch, a steel screw steamer, the *Lismore Castle*, for the Castle Mail Packet Company, Limited. She is fitted throughout with the electric light, &c.

On Tuesday the British India Company's steamer *Amra* ran her official trial on the Clyde, when a mean speed of 12·8 knots was obtained, notwithstanding that the weather was stormy. The *Amra* is fitted throughout with the electric light.

**Personal.**—Mr. A. W. Jones has resigned the post of Chief Electrician to the Exeter Electric Light Company, Exeter, and has joined the Laing, Wharton and Down Construction Syndicate.

**Electricity in the French Navy.**—A telegram from Brest states that the Minister of Marine has decided that every military port shall send to Paris two foremen and two working electricians to study the various systems of electric lighting. Lectures upon the theory and use of electricity and its employment for naval purposes will commence at the Observatory here on the 11th inst., and will be continued for four months.

**A Correction.**—A friend writes:—"I have just seen in the ELECTRICAL REVIEW of last week a paragraph copied from a Madrid paper, called *Los Anales de la Electricidad*, and saying that we intend to work Ferranti machines at 10,000 volts here. The machines are Ferranti's, but 2,400 volts, not 10,000, a slight difference. The underground cables are of the best Silver-town make, and the same as are being, and have been used in London for some time. I know you will be good enough just to mention the error in your next issue, as it may frighten some of our friends here if they saw it."

**Vienna Telephones.**—It is thought probable that the management of the Vienna telephones will be taken over by the State. The International Postal Congress will assemble at Vienna on May 20th, 1891.

**The Royal Institute of British Architects.**—At a meeting held at the Royal Institute of British Architects on Monday, the 3rd instant, the council room of the Institute was lit by electric light. The electric light installation is being carried out by the Planet Electrical Engineering Company, and, for the evening, a temporary connection was made with accumulators in the council room. The lighting gave satisfaction to the members of the Institute who were present.

**Electricity is (Indirectly) Life!**—Says the *Financial News* of yesterday:—"When the Prince of Wales opened the electric railway from the Monument to Stockwell, he may have thought that the utility of the work was limited to increasing the convenience of traffic. He was mistaken, as Sir John Fowler took the liberty of reminding His Royal Highness. So pure is to be the air in these electric tunnels, that Sir John, with his keen engineer's eye, can see a day in which doctors will send their suffering patients to the lower realms—not in the old, accustomed way, but to mend impaired health in an atmosphere more salubrious than on earth—on London earth, that is. We advance indeed. Fancy an asthma patient prescribed a course of the Inner Circle!"

**The Electric Light at Barnet.**—A gas contemporary says: More complaint has been made by the Barnet Local Board of the deficient lighting furnished by the electric lamps, and the contractor (Mr. Joel) has been again remonstrated with on the subject. At the last meeting of the board his reply was received, and its reading caused much amusement. He said he had ordered a number of 32 candle-power lamps for use at Barnet, but that the maker had sent 50 candle lamps instead, so that the district was actually being lighted by 32 and 50 candle-power lamps. When the mirth which this statement produced had subsided, a proposition was brought forward that the thanks of the board should be given to the contractor for his generosity. But this did not find a seconder; probably from the fact that it was regarded as sarcasm. A member asked the Clerk if his eyes had not played him false, causing him to read 50 for 15. The Clerk replied that the figure was 50. In the whole history of this extraordinary lighting undertaking, nothing has equalled this. As the local paper remarks, "The wildest dreams of the most enthusiastic resident never suggested a ray in excess of the contract light; so the Barnet Local Board may be pardoned a little surprise at the revelation."

**Dangers of the Electric Light.**—According to the *West Middlesex Advertiser*, the landlord and employes of the Markham Arms are not likely to forget the night of Monday, October 20th, 1890. The experience they then underwent, while certainly of a novel was yet of an alarming character. Late in the evening, just previous to turning out the lights, something unusual was noticed to be the matter with the electric incandescent lamps. Mr. Dew rushed to the switch and turned it off, but not before the lamps which were attached to the three large gas chandeliers in the bar were smashed to pieces, and great streaks of fire over a yard long had been streaming from the tubes, to which the platinum wire had been fastened, previous to its being broken and carried away with the globe. The box by the side of the switch was burned. Great damage was done both up and down stairs. It should be stated that at the Markham Arms is a most thorough installation of the electric light; this form of illumination being used in every part of the house. Mr. Dew, the housekeeper, and others residing on the premises, are at a loss to know the cause of the fire, and they state that if the enormous pressure of electricity had been kept up half a minute later, or if Mr. Dew had not turned the switch when he did, nothing could have saved the house from being destroyed by fire. "Three of us were standing in the bar at the time," remarked the housekeeper to our representative, "and it was an awful sight; I prefer the old gas to this, it's much safer." The electric supply at the Markham Arms was laid on by the Cadogan Electric Company, Manor Street.

**Telephony in France.**—According to the *Figaro*, the following towns are telephonically connected with Paris:—Lille, Rouen, Le Havre, Elbeuf, Rheims, Lyons, and Marseilles, whilst the line to Brussels is the longest. There are also connected with Paris:—Amiens-Arras-Lille, Saint Quentin, Paris-Orleans, Paris-Troyes, and it is proposed to further extend the telephone service with Epinal as the centre. There are 8,000 subscribers in Paris, 1,800 of whom have joined this year, whilst in the provinces the total is 6,000. The whole service is summed up as 22 distributing networks in Paris and district, 50 local installations, of which two are in Algiers, 20 connections with other towns, and 12 for long-distance telephony.

**The "Peral."**—The latest news from Spain with regard to the unfortunate *Peral*, which, after all, seems to be neither fish, flesh, fowl, nor good red herring, is to the effect that the Supreme Naval Council confirms the decision of the Technical Commission held at Cadiz; but while affirming that no new idea has been originated in the construction, and that no practical use can be made of the fabric, the Supreme Council authorises Lieut. Peral to continue his experiments on a new scheme. By this decision, the Supreme Council, says the Madrid Press, has acquired the rare distinction of having surprised the whole world.

**Electricity Superseded.**—Jules Verne, whose romances were at one time ridiculed, has lived to see some of them almost realised; but he will now have to take a back seat. Mr. Weems's system of electric traction, and the portelectric system, are also put in the shade by the high-sounding Mount Carmel Aeronautic Navigation Company, who propose to run air ships carrying passenger cars the size of Pullman cars. The ships will be built of aluminium, and are to travel through the air at a terrific speed. Mails will be dropped from the ships into mail bags below, as they scud through the rarefied atmosphere.

**The Paris-London Telephone.**—It is announced in Paris that telephonic communication between that city and London will be opened on January 1st.

**The Progress of Electrical Firms.**—Our contemporary *Money* devotes considerable space to the rise of Messrs. Laurance, Scott and Company, Limited. Commencing seven years ago as a private concern, electrical apparatus was manufactured in a small way. Gradually growing, and becoming limited in a company sense, the business has assumed proportions which few companies equal and fewer surpass. The dynamo room is at present full of orders, among others being an important one from the Chelsea Electricity Supply Company. Under its auspices a local company has been floated, which will doubtless supply current to the town. A central station is already supplying light to the works and the principal places around.

### NEW COMPANIES REGISTERED.

**Llangammarch Estate and Land Company, Limited.**—Capital £100,000 in £10 shares. Objects: To acquire lands and buildings in the county of Brecon, or elsewhere, and particularly the Tyncoed Farm, parish of Llanlleonfel, and to carry on building operations. To construct, work and manage electric power, heat and light supply works, telephone and other works. Signatories (with 10 shares each): H. Watkin Lewis, Merthyr Tydvil; D. T. Alexander, Cardiff; R. A. Bowring, Penarth; C. J. Jackson, Cardiff; J. Wesley Courtes, Cardiff; Lascelles Carr, Tredelerch near Cardiff; J. E. Gunn, Cardiff; M. Tennant, Aberavon. Directors' qualification, £100 in shares or stock; the company in general meeting will determine remuneration. Registered 30th ult. by A. H. Atkins, agent for Tennant and Jones, Aberavon.

**Electrical Supplies and Fittings Company, Limited.**—Capital £20,000 in £5 shares. Objects: To carry on in the United Kingdom the business of electricians and mechanical engineers, and in particular to construct, purchase, sell, establish, fix and maintain all necessary motors, cables, wires, accumulators, insulators, lamps, electroliers, &c. Signatories (with one share each): J. L. A. Rooke (electrical engineer), 14, Keppel Street, W.C.; J. N. Roxburgh, 77, Queen's Road, Finsbury Park; J. Whitehead (electrical engineer), Haycot, Crouch End; F. B. Arundell, 1, Devonshire Street, Portland Place; W. L. Madgen, 3, Princes Mansions, Victoria Street; N. G. Bingham, C.E., 29, Notting Hill Terrace; G. E. Butler, 15, Park Hill, Sydenham. The signatories are to appoint the first director, qualification, £200 in share capital, remuneration £500 per annum, together with one-tenth of the net profits remaining after payment of 8 per cent. dividend on the ordinary share capital, but not to exceed £1,000 per annum. Registered 31st ult., by Wilson, Bristows & Carpmal, 1, Copthall Buildings.

**United Alkali Company, Limited.**—Capital, £6,000,000 in £10 shares. Objects: To manufacture chemical products and drugs of all kinds. To carry on business as metallurgists in all branches, and also as waterproofer and India-rubber and leather manufacturers. To carry on any business, or businesses, directly or indirectly connected with the generation, accumulation, distribution, supply or application of electricity. Signatories (with 1 share each), \*John Brock; H. Gaskell, Widnes; J. K. Huntley, Flint; \*Chas. Wigg, J. Dennis and \*E. K. Muspratt, Liverpool; \*A. W. Allhausen; \*J. Tennant, Gateshead; \*J. C. Davidson, Newcastle; \*C. E. Barlow; \*H. Gaskell, Jr.; \*Robert Shaw, Widnes; \*J. C. Stevenson, M.P., South Shields; \*G. L. Wigg, Runcorn; \*P. J. Worsley, Bristol; \*J. A. E. Rayner, \*W. J. Menzies, Widnes. The signatories and Thomas Alexander, E. Baxter and J. Gaskell are the first directors; qualification, £1,000 in shares or stock; remuneration, chairman, £2,500 per annum, with an additional £500 per annum in each year in which at least 8 per cent. is paid on the ordinary shares; the other directors will be remunerated at the rate of £400 per annum each. Registered 1st inst. by H. Forshaw and Hawkins, of 5, Castle Street, Liverpool.

### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**South Staffordshire Electric Lighting Company, Limited.**—The annual return of this company, made up to the 30th ult., was filed on the 31st ult. The nominal capital is £100,000, in £5 shares; 139 shares are taken up, and the full amount has been called thereon. The calls paid amount to £690, and unpaid to £5.

**Head, Wrightson & Co., Limited** (engineers, electricians, &c.).—The statutory return of this company, made up to the 7th ult., was filed on the 18th ult. The nominal capital is £210,000, in £5 shares, the whole of which are taken up, 13,999 shares being considered as fully paid. The calls received amount to £140,005.

An extraordinary meeting of the company was held on the 23rd September, when it was resolved that the following be substituted for Clause 19 of the articles of association:—

"The directors may, subject to the regulations of these presents, from time to time make such calls upon the shareholders in respect of all moneys unpaid on their shares as they think fit, provided that 21 days' notice at least is given of each call, and that no call in respect of any share shall exceed one-fourth of the nominal amount of such share, or be made payable within two months after the last preceding call was payable, and each shareholder shall be liable to pay the amount of every call so made upon him to the persons and at the times and places appointed by the directors." This resolution was confirmed on the 8th ult., and filed 15th ult.

**Dick Kerr and Company, Limited** (engineers and electricians).—The statutory return of this company, made up to the 9th ult., was filed on the 17th ult. The nominal capital is £160,000, in £5 shares, the whole of which are taken up, one half being considered as fully paid. The remaining capital is also paid up.

**New Electric Fire Lighter Company, Limited.**—The statutory return of this company is made up to the 28th ult. The nominal capital is £10,000, in £1 shares. 602 shares are taken up, and the full amount has been called thereon. The calls paid amount to £500, and unpaid to £102.

### CITY NOTES, REPORTS, MEETINGS, &c.

#### Westminster Electric Supply Corporation, Limited.

THE report presented at the meeting held on Wednesday states the affairs of the corporation are proceeding in a rapid and satisfactory manner.

The first work which claimed their attention, after the allotment of the shares, was that of obtaining suitable sites for central stations, three of which were required for the supply of the district which had been allotted to the corporation.

In January last the board acquired the undertaking of the City of Westminster Electrical Syndicate, Limited, who had commenced business in the district, and thereby obtained possession of St. John's Wharf, Millbank Street, and also of the contract for electric lighting in the Houses of Parliament.

After considerable trouble and delay, the board succeeded in obtaining two other eligible sites—one in Eccleston Place, Belgravia, and the other in Davies Street, Mayfair, both being on the Duke of Westminster's estate.

Pending the installation of the large central stations, current has been supplied from two temporary stations—one in the stone-yard adjacent to the Houses of Parliament and the other in Dacre Street, Victoria Street. By means of these temporary stations, the nucleus of a good business has been formed, and at the present time current is being supplied from underground mains equivalent to about 6,000 8-C.P. lamps on circuit. The demand for current already far exceeds the amount which can be generated from the plant in actual work, but the new station at St. John's Wharf is now running, and able to take over the work in the Westminster District and allow the Dacre Street plant to supply as far as Belgrave Square, pending the completion of the Eccleston Place Station.

The installations in Mayfair and Belgravia are rapidly advancing; the mains have been laid in many of the principal streets, and are being laid as quickly as possible in the others, and

the Board hope that current will be supplied from both these stations early in the New Year.

The board have ordered plant (viz., engines, boilers, dynamos, batteries, &c.) to the amount of about 2,600 indicated horsepower for the three stations, a large part of which has already been delivered. This will be sufficient to supply about 40,000 8-C.P. lamps alight at one time, allowing an ample margin for steam power in reserve. According to present experience this will correspond to upwards of 100,000 8-C.P. lamps on circuit.

The system of distribution adopted is the low tension continuous current. The mains already laid are shown on maps, which can be seen at the corporation's offices, and amount in all to nearly 11 miles, and permission has already been obtained from the authorities for the whole system of proposed mains.

The financial year ends on the 31st December, and the accounts will be made up and audited to that date, and the board recommend that in future the annual general meeting of the shareholders should be held in the month of February, when the accounts would be ready for presentation.

Lord Suffield (the chairman) said great progress had been made with their works, as indicated by the maps. There had been completed nearly 11½ miles of mains. He congratulated them on the progress made. The Millbank Street Station was in working order, and he considered they were greatly indebted to their chief engineer (Prof. Kennedy), who had shown great energy in carrying out the work. The other stations were in a fair condition, excavation was proceeding at the Davies Street Station. It was satisfactory to know that all the engines and machinery were ready whenever they were ready to receive it. In answer to various shareholders, he said the applications for current were very numerous, and were coming in every day. They could not, of course, supply these demands, but he hoped by the early part of the year they would supply all that would be required. When they would be able to pay a dividend he could not say. Expenses were very heavy, and it would be necessary to call up the whole of the capital shortly. With regard to the question of monopoly, in some parts of the district they were running side by side with another company, but in other parts they were alone. There would certainly be rivalry, and it was necessary that they made their system as near perfection as possible.

Mr. Scott (a shareholder) spoke in very favourable terms of the works which he had seen only recently. He recommended that a further remuneration should be given to the directors.

In reply to questions on the estimates, Prof. Kennedy said they were well within the stated sums.

The meeting terminated with a vote of thanks to the board.

### Montevideo Telephone Company.

At the meeting held on Friday last, the Chairman (Mr. Holland) said the report was not as satisfactory as they desired, and certainly not in accord with the indications held out at the last meeting, and at the meetings where they were asked to increase the capital of the company, for the purpose of multiple switchboards and other improvements. It was, however, satisfactory in the respect of profits, for, as shown in the report, it was about equal to that of last year, and this time they had passed through a period of great depression, which was felt both at Montevideo and Buenos Ayres. Although telephones in many cases were articles of necessity, they were in many others articles of luxury and convenience, and when there came a time in which it was imperative for customers to exercise economy, the tendency was to dispense with the telephones. The company had suffered a great deal in this way, and many withdrawals had resulted from the stagnant state of business in Montevideo. On the other hand, owing to the improvements which the shareholders sanctioned some time ago, they had a considerable number of new shareholders to take the place of those who had withdrawn, consequently they were financially about in the same position as last year. They had deducted from the profits small expenses for preliminary and depreciation on furniture; this would be written off in a few years. They would propose a full dividend of 6 per cent. on the preference shares, and to carry £1,000 to depreciation fund, and another £1,000 to reserve fund, because, in the present state of things, they deemed it prudent to have a substantial reserve. He continued to hope that when the wave of depression had passed, they would receive full benefit of all the money they had spent out there. As stated in the report, they had spent a considerable sum in extending wires and cables to new subscribers. Under the head of profit and loss there was an increase in the subscriptions of £891, on the other hand there was an increase in the expenditure of £1,130, owing to extra taxes which they had been called upon to pay, and also on account of extra insurance. Expenses in London were a little higher, owing to the fact that in the previous 12 months they had received a little consideration from the company, for whom they turned out of their old offices. Expenses in Montevideo amounted to 48 per cent. of their receipts; this compared very favourably with the telephone company on the other side of the river, whose expenses were 61 per cent. of the receipts. It showed that on their part there had been good management. He considered that the ordinary stock of the company would before long be very valuable property. Had there been no withdrawals and the same influx of new subscribers they could have paid their ordinary shareholders 6 per cent. In conclusion, he moved the adoption of the report and accounts.

Mr. T. D. Peters seconded, and the motion was carried unanimously.

The resolution as to the dividend was then put to the meeting and carried.

The Chairman moved, and Mr. E. F. Powers seconded, that the retiring director, Mr. Peters, be re-elected a director, which was done.

The auditors, Messrs. Gérard Van de Linde and Son, were re-elected at a remuneration of 20 guineas.

The meeting then terminated.

### The West India and Panama Telegraph Company, Limited.

THE directors submit the accounts for the six months ended 30th June, 1890. The amount to credit of revenue is £52,351 2s. 4d. (against £49,985 11s. 9d. for the corresponding half-year of 1889), and the expenses have been £26,669 17s. 4d. (against £24,458 6s. 9d. for the same period in 1889), leaving a balance of £25,681 5s., which, with the balance of £516 19s. 8d. brought from last account, makes a total of £26,198 4s. 8d. Of this sum the directors have placed £1,500 to reserve, leaving an available balance of £24,698 4s. 8d., with which it is proposed to deal as follows:—

	£	s.	d.
First preference shares—			
Dividend, 6 months to 30th June, 6s.			
per share ... ..	10,368	18	0
Second preference shares—			
On account of arrears of dividend to			
30th June, £3 per share ... ..	14,007	0	0
Balance to current half year's account ... ..	322	6	8
	£24,698	4	8

The traffic receipts for the six months show an increase of £2,779 7s., as compared with the corresponding period.

Several interruptions to the cables occurred during the half-year, and the expenses for repairs amount to £13,936 8s. 3d., being £2,900 19s. 11d. more than those for the corresponding six months.

The shareholders will remember that at the time of the last general meeting, negotiations were in progress with the Government of Barbados to lay a second cable to that colony in consideration of the continuance of the subsidy of £2,500 per annum for a period of 10 years. The necessary Act having been passed, the new cable was successfully laid between Barbados and St. Vincent in July last.

In consequence of the laying of the new lines above referred to out of the stock of cable in the West Indies, it has become necessary to replenish that stock for repairing purposes, and a contract has been entered into with Siemens Brothers and Company, Limited, for the manufacture of 215 knots of cable, which will be conveyed to the West Indies in the company's steamship, *Grappler*, which arrived in the Thames on the 21st inst.

The Danish colonies of St. Thomas and St. Croix have renewed their subsidies for a further term of five years from the 31st December last.

**Western and Brazilian Telegraph Company.**—The directors propose, after placing £7,500 to the renewal fund and £5,880 to the debenture redemption fund, a dividend at the rate of 4 per cent. per annum for the six months ending June 30th, last.

**Middlesborough Electric Light Company.**—Certificates were ready on Monday and will be exchanged for bankers receipts at the London office, Blomfield House, New Broad Street, E.C.

### TRAFFIC RECEIPTS

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending October 31st were £5,411.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of October were £3,200 as compared with £2,903 in the corresponding month of last year. The receipts for the month of July, estimated at £3,150, realised £3,134.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of October show an increase of £154 as compared with the corresponding period.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of October, 1890, amounted to £47,117, as against £45,679 in the corresponding period, an increase of £1,438.

The Eastern Telegraph Company, Limited. The receipts for the month of October were £39,589, as against £32,981 for the same period of 1889, or a decrease of £3,392.

The Great Northern Telegraph Company, Limited. The receipts for the month of October amounted to £28,000; 1st January—31st October 1890, £232,800; corresponding months 1889, £229,200; do. 1888, £226,200.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 31st, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,235.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of October, 1890, were £3,800.

The West India and Panama Telegraph Company. The receipts for the half-month ended October 31st, are £2,910, as compared with £2,735 in the corresponding period of 1889.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (October 30).	Closing Quotation. (November 6.)	Business done during week ending November 6, 1890.
					Highest. Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	99 — 102	99 — 102	
1,549,160	Anglo-American Telegraph, Limited	Stock	48½ — 49½	49 — 50	49
2,725,420	Do. do. 6 p. c. Preferred	Stock	84½ — 85½	85 — 86	85½ 85½
2,725,420	Do. do. Deferred	Stock	13 — 13½	13½ — 13½	13½ 13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 11½	11½ — 11½	11½ 11½
84,500	Do. do. 5 p. c. Bonds	100	100 — 102	101 — 103	101 103 xd & bonus
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	103 — 107	104 — 108	
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 1½	1½ — 1½	
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2	
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	½ — ½ xd	½ — ½ xd	
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½	
16,000	Cuba Telegraph, Limited	10	11½ — 12	11½ — 12	12 11½
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4½	3½ — 4½	
6,090	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½ xd	10½ — 10½ xd	10½ 10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14	13½ — 14	14 13½
70,000	Do. do. 6 p. c. Preference	10	14½ — 15½	14½ — 15½	15½ 14½
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	
1,290,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	103 — 106 xd	103 — 106	105
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½	14 — 14½	14½ 14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102	
91,800	{ Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326 }	{ 100 }	{ 102 — 105 }	{ 102 — 105 }	
325,200	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400	100	102 — 105	102 — 105	
145,800	{ Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	{ 100 }	{ 101 — 104 }	{ 101 — 104 }	
198,200	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 — 104	101 — 104	
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8	8 — 8½	8½
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½	
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5½	5 — 5½	5½ 4½
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid) }	{ 2 }	{ 1½ — 1½ }	{ 1½ — 2½ }	{ 1½ }
20,000	Fowler-Waring Cables, Nos. 301 to 20,000	5	3½ — 4	2½ — 3	
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	9 — 8½	9 8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15	14½ — 14½	14½ 14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	15½ 15½
15,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104	
230,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107	
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½	
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½	
41,609	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18½ — 19½	
200,000	Do. do. 4½ p. c. Deb., 1896	100	100 — 102 xd	100 — 102	
17,000	Indo-European Telegraph, Limited	25	35 — 37 xd	35 — 37 xd	36½ 35½
11,334	International Okonite, Ltd, Ordinary Nos. 22,667 to 34,000 (£7 pd.)	10	6½ — 7	6½ — 7	
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	6½ — 7	6½ — 7	
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6½ — 7½	
109,000	Do. do. do. 6 p. c. Debentures	100	105 — 108	105 — 108	
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5½ — 6	5 — 5½	
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4½ — 4½	4½ — 4½	4½ 4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½	12½
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½ — 10½	9½ — 10½	
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8½ — 8½	8½ — 8½	
9,000	Reuter's, Limited	8	8½ — 8½	8½ — 8½	8½
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	{ 1 }	{ 8½ — 8½ }	{ 8½ — 8½ }	
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£2½ only paid)	5	2½ — 3 xd	2½ — 3 xd	2½ 2½
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117	
78,949	Swan United Electric Light, Limited	5	5 — 5½	5 — 5½	5½ 5½
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	45
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	
146,128	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94	
3,200	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½ — 9½	8½ — 9½	
290,900	Do. do. do. 5 p. c. Debentures	100	98 — 101	98 — 101	
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	4
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	102 — 107	102 — 107	
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11½ 11½
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 7	7 6½
27,873	Do. do. do. 5 p. c. Deferred	7½	4½ — 5	4½ — 5	
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106	
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106	
88,321	West India and Panama Telegraph, Limited	10	3 — 3½	3 — 3½	3½ 3½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 12	11½ 11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	14 — 15	14 — 15	
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	122 — 127	120 — 125 xd	122½
175,100	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103	
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 3	2½ — 3	2½

\* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7 — 7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 2½—2½.—House-to-House Company (£5 paid), 4½—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/- — 13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2½—3.—Preference, 4½—4½.

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 536.)

On examining the numbers in detail we observe that the largest number of magnetic lines forced round the bend of the iron core, through the coil *c*, was 24,040 (the cross section being a little over 1 square centimetre), which was when the armature was in contact. When the armature was away, the same magnetising power only evoked 9,795 lines. Further, of those 24,040, 23,660 (or 98½ per

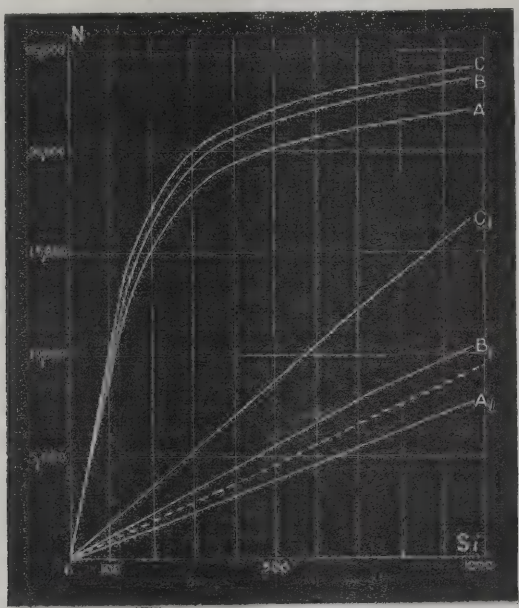


FIG. 44.—CURVES OF MAGNETISATION PLOTTED FROM PRECEDING.

cent.) came up through the polar surfaces of contact, and of those again 21,980 (or 92½ per cent. of the whole number) passed through the armature. There was leakage, then, even when the armature was in contact, but it amounted to only 7½ per cent. Now, when the armature was moved but 1 millimetre (i.e.,  $\frac{1}{32}$ th inch) away, the presence of the air-gaps had this great effect, that the total magnetic flux was at once choked down from 24,040 to 17,220. Of that number only 10,810 (or 61 per cent.) reached the polar surfaces, and only 8,110 (or 47 per cent. of the total number) succeeded in going through the armature. The leakage in this case was 53 per cent. ! With a 2 millimetre gap, the leakage was 65 per cent. when the strongest current was used. It was 68 per cent. with a 5 millimetre gap, and 80 per cent. with a 10 millimetre gap. It will further be noticed that whilst a current of 0.7 ampère sufficed to send 12,506 lines through the armature when it was in contact, a current 8 times as strong could only succeed in sending 8,110 lines when the armature was distant by a single millimetre.

Such an enormous diminution in the magnetic flux through the armature consequent upon the increased reluctance and increased leakage occasioned by the presence of the air-gaps, proves how great is the reluctance offered by air, and how essential it is to have some practical rules for calculating reluctances and estimating leakages to guide us in designing electro-magnets to do any given duty.

The calculation of magnetic reluctances of definite portions of a given material are now comparatively easy, and, thanks to the formulæ of Professor Forbes, it is now possible in certain cases to estimate leakages. Of these methods of calculation an abstract will be given in the appendix to this lecture. I have, however, found Forbes's rules, which were intended to aid the design of dynamo machines, not very convenient for the common cases of electro-magnets, and have therefore cast about to discover some more apposite mode of calculation. To predetermine the probable percentage of leakage one must first distinguish between those magnetic lines which go usefully through the armature (and help to pull it) and those which go astray through the surrounding air and are wasted so far as any pull is concerned. Having set up this distinction, one then needs to know the relative magnetic conductance, or permeance, along the path of the useful lines and that along the innumerable paths of the wasted lines of the stray field. For (as every electrician accustomed to the problems of shunt circuits will recognise) the quantity of lines that go respectively along the useful and wasteful paths will be directly proportional to the conductances (or permeances) along those paths, or will be inversely proportional to the respective resistances along those paths. It is customary in electro-magnetic calcula-

tions to employ a certain coefficient of allowance for leakage, the symbol of which is *v*, such that when we know the number of magnetic lines that are wanted to go through the armature we must allow for *v* times as many in the magnet core. Now, if *u* represents permeance along the useful path, and *w* the permeance of all the waste paths along the stray field, the total flux will be the useful flux as *u + w* is to *u*. Hence the coefficient of allowance for leakage *v*, is equal to *u + w* divided by *u*. The only real difficulty is to calculate *u* and *w*. In general *u* is easily calculated, it is the reciprocal of the sum of all the magnetic reluctances along the useful path from pole to pole. In the case of the electro-magnet used in the experiments last described, the magnetic reluctances along the useful path are three in number, that of the iron of the armature, and those of the two air-gaps. The following formula is applicable,

$$\text{reluctance} = \frac{l_1}{A_1 \mu_1} + \frac{2 l_2}{A_2},$$

if the data are specified in centimetre measure; the suffixes 1 and 2 relating respectively to the iron and to the air. If the data are specified in inch measures the formula becomes

$$\text{reluctance} = 0.3132 \left\{ \frac{l'_1}{A'_1 \mu_1} + \frac{2 l'_2}{A'_2} \right\}$$

But it is not so easy to calculate the reluctance (or its reciprocal, the permeance) for the waste lines of the stray field, because the paths of the magnetic lines spread out so extraordinarily and bend round in curves from pole to pole.

Fig. 45 gives a very fair representation of the spreading of the lines of the stray field that leaks across between the two limbs of a horse-shoes electro-magnet made of round iron. And for square iron the flow is much the same, except that it is concentrated a little by the corners of the metal. Forbes's rules do not help us here. We want a new mode of considering the subject.

The problems of flow, whether of heat, electricity, or of magnetism, in space of three dimensions, are not amongst the most easy of geometrical exercises. However, some of them have been worked out, and may be made applicable to our present need. Consider, for example, the electrical problem of finding the resistance which an indefinitely extended liquid (say a solution of sulphate of copper of given density) offers when acting as a conductor of electric currents flowing across between two indefinitely long parallel cylinders of copper. Fig. 45 may be regarded as

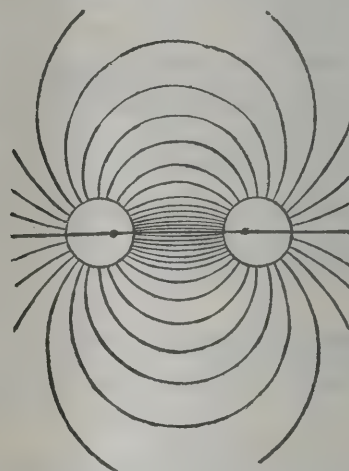


FIG. 45.—CURVES OF FLOW OF MAGNETIC LINES IN AIR FROM ONE CYLINDRICAL POLE TO ANOTHER.

representing a transverse section of such an arrangement, the sweeping curves representing lines of flow of current. In a simple case like this it is possible to find an accurate expression for the resistance (or for the conductance) of a layer or stratum of unit thickness. It depends on the diameters of the cylinders, on their distance apart, and on the specific conductivity of the medium. It is not by any means proportional to the distance between them, being, in fact, almost independent of the distance, if that is greater than twenty times the perimeter of either cylinder. Neither is it even approximately proportional to the perimeter of the cylinders except in those cases when the shortest distance between them is less than a tenth part of the perimeter of either. The resistance, for unit length of the cylinders, is, in fact, calculated out by the rather complex formula:—

$$R = \frac{1}{\pi \mu} \log. \text{nat. } h;$$

Where

$$h = \frac{2a}{b + 2a - \sqrt{b^2 + 4ab}};$$

the symbol *a* standing for the radius of the cylinder; *b* for the shortest distance separating them; *μ* for the permeability, or in the electric case the specific conductivity of the medium.

Now, I happened to notice, as a matter that greatly simplifies the calculation, that if we confine our attention to a transverse

\* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

layer of the medium of given thickness, the resistance between the two bits of the cylinders in that layer depends on the ratio of the shortest distance separating them to their periphery, and is independent of the absolute size of the system. If you have the two cylinders an inch round, and an inch between them, then the resistance of the slab of medium (of given thickness) in which they lie will be the same as if they were a foot round and a foot apart. Now that simplifies matters very much, and thanks to my friend and former chief assistant, Dr. R. Mullineux Walmsley, who devoted himself to this troublesome calculation, I am able to give you, in tabular form, the magnetic resistances within the limits of proportion that are likely to occur.

The numbers from columns 1 and 2 of the following table are

TABLE VIII.—MAGNETIC RELUCTANCE OF AIR BETWEEN TWO PARALLEL CYLINDRICAL LIMBS OF IRON.

$\frac{b}{p}$ Ratio of least distance apart to peri- meter.	Magnetic reluctance in C.G.S. units = the magneto-motive force ÷ total magnetic flux.		Magnetic reluctance in inch units = the ampere-turns ÷ the total magnetic flux. Slab = 1 inch thick.	
	Reluctance.	Permeance.	Reluctance.	Permeance.
0.1	0.2461	4.063	0.0771	12.968
0.2	0.3404	2.938	0.1066	9.377
0.3	0.4084	2.449	0.1280	7.815
0.4	0.4628	2.161	0.1450	6.897
0.5	0.5084	1.967	0.1593	6.278
0.6	0.5479	1.825	0.1717	5.825
0.8	0.6140	1.629	0.1924	5.198
1.0	0.6681	1.497	0.2093	4.777
1.2	0.7144	1.400	0.2238	4.571
1.4	0.7550	1.324	0.2365	4.228
1.6	0.7903	1.265	0.2476	4.039
1.8	0.8220	1.217	0.2575	3.883
2.0	0.8511	1.202	0.2667	3.750
4.0	1.0500	0.952	0.3290	3.040
6.0	1.1710	0.854	0.3669	2.726
8.0	1.2624	0.792	0.3955	2.528
10.0	1.3250	0.755	0.4151	2.409

NOTE.—In the above table, unit length of cylinders is assumed (1 centimetre in columns 2 and 3; 1 inch in columns 4 and 5); the flow of magnetic lines being reckoned as in a slab of infinite extent, and of unit thickness. Symbols:  $p$  = perimeter of cylinder;  $b$  = shortest distance between cylinders. In columns 2 and 3 the unit reluctance is that of a centimetre cube of air. In columns 4 and 5 the unit reluctance is so chosen (as in the rest of these lectures wherever such measures are used), that the reduction of ampère turns to the magneto-motive force by multiplying by  $4\pi \div 10$  is avoided. This will make the reluctance of the inch cube of air equal to  $10 \div 4\pi \div 2.54 = 0.3132$ ; and its permeance as  $3.1931$ .

plotted out graphically in Fig. 46 for more convenient reference. As an example of the use of the table we will take the following:—

EXAMPLE.—Find the magnetic reluctance and permeance between two parallel iron cores of 1 inch diameter and 9 inches long, the least distance between them being  $2\frac{3}{8}$  inches. Here  $b = 2.375$ ;  $p = 3.1416$   $b \div p = 0.756$ . Reference to the table shows (by interpolation) that the reluctance and permeance for unit thickness of slab are respectively 0.183 and 5.336. For 9 inches thickness they will therefore be 0.021 and 48.02 respectively.

When the permeance across between the two limbs is thus approximately calculable, the waste flux across the space is estimated by multiplying the permeance so found by the average value of the difference of magnetic potential between the two limbs. And this, if the yoke which unites the limbs at their lower end is of good solid iron, and if the parallel cores offer little magnetic reluctance as compared with the reluctance of the useful paths, or of that of the stray field, may be simply taken as half the ampère-turns (or, if centimetre measures are used, multiply by 1.2566).

The method here employed in estimating the reluctance of the waste field is of course only an approximation; for it assumes that the leakage takes place only in the planes of the slabs considered. As a matter of fact, there is always some leakage out of the planes of the slabs. The real reluctance is always therefore somewhat less, and the real permeance somewhat greater, than that calculated from Table VIII.

For the electro-magnets used in ordinary telegraph instruments the ratio of  $b$  to  $p$  is not usually very different from unity, so that for them the permeance across from limb to limb per inch length of core is not very far from 5.0, or nearly twice the permeance of an inch cube of air.

We are now in a position to see the reason for a curious statement of Count du Moncel which for long puzzled me. He states that he found, using distance apart of one millimetre, that the attraction of a two-pole electro-magnet for its armature was less when the armature was presented laterally than when it was placed in front of the pole-ends, in the ratio of 19 to 31. He does not specify in the passage referred to what was the shape of either the armature or the cores. If we assume that he was referring to an electro-magnet with cores of the usual sort—round iron with

flat ends, presumably like fig. 11—then it is evident that the air gaps, when the armature is presented sideways to the magnet, are really greater than when the armature is presented in the usual way, owing to the cylindrical curvature of the core. So, if at equal measured distance the reluctance in the circuit is greater, the magnetic flux will be less and the pull less.

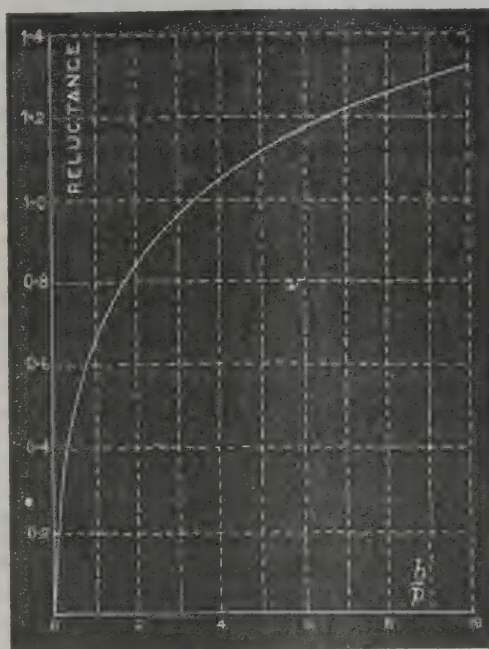


FIG. 46.—DIAGRAM OF LEAKAGE RELUCTANCES.

It ought also now to be evident why an armature made of iron of a flat rectangular section, though when in contact it sticks on tighter edgeways, is at a distance attracted more powerfully if presented flatways. The gaps, when it is presented flatways (at an equal least distance apart) offer a lesser magnetic reluctance.

Another obscure point also becomes explainable, namely, the observations by Lenz, Barlow, and others, that the greatest amount of magnetism which could be imparted to long iron bars by a given circulation of electric current was (nearly) proportional, not to the cross-sectional area of the iron, but to its surface; The explanation is this. Their magnetic circuit was a bad one, consisting of a straight rod of iron and of a return path through air. Their magnetising force was being in reality expended not so much on driving magnetic lines through iron (which is readily permeable) but on driving the magnetic lines through air (which is, as we know, much less permeable), and the reluctance of the return paths through the air is—when the distance from one to the other of the exposed end parts of the bar is great compared with its periphery—very nearly proportional to that periphery, that is to say, to the exposed surface.

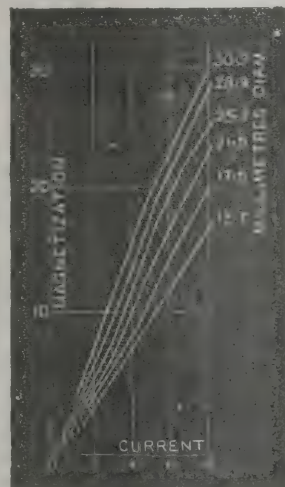


FIG. 47.—VON FEILITZSCH'S CURVES OF MAGNETISATION OF RODS OF VARIOUS DIAMETERS.

Another opinion on the same topic was that of Professor Müller, who laid down the law that for iron bars of equal length, and excited by same magnetising power, the amount of magnetism was proportional to the square root of the periphery. A vast amount of industrious scientific effort has been expended by Dub, Hankel, Von Feilitzsch, and others on the attempt to verify this "law." Not one of these experimenters seems to have had the faintest suspicion that the real thing which determined the amount of magnetic flow was not the iron but the reluctance of the return path through air. Von Feilitzsch plotted out the accompanying curves (Fig. 47), from which he drew the

inference that the law of the square root of the periphery was established. The very straitness of these curves shows that in no case had the iron become so much magnetised as to show the bend that indicates approaching saturation. Air, not iron, was offering the main part of the resistance to magnetisation in the whole of these experiments. I draw from the very same curves the conclusion that the magnetisation is not proportional to the square root of the periphery, but is more nearly proportional to the periphery itself; indeed, the angles at which the different curves belonging to the different peripheries rise show that the amount of magnetism is very nearly as the surface. Observe here we are not dealing with a closed magnetic circuit where section comes into account; we are dealing with a bar in which the magnetism can only get from one end to the other by leaking all round into the air. If, therefore, the reluctance of the air path from one end of the bar to the other is proportional to the surface, we should get some curves very like these; and that is exactly what happens. If you have a solid, of a certain given geometrical form, standing out in the middle of space, the conductance which the space around it (or rather the medium filling that space), offers to the magnetic lines flowing through it, is practically proportional to the surface. It is distinctly so for similar geometrical solids, when they are relatively small as compared with the distance between them. Electricians know that the resistance of the liquid between two small spheres, or two small discs of copper immersed in a large bath of sulphate of copper, is practically independent of the distance between them, provided they are not within ten diameters, or so, of one another. In the case of a long bar we may treat the distance between the protruding ends as sufficiently great to make an approximation to this law hold good. Von Feilitzsch's bars were, however, not so long that the average value of the length of path from one end surface to the other end surface, along the magnetic lines, was infinitely great as compared with the periphery. Hence the departure from exact proportionality to the surface. His bars were 9.1 centimetres long, and the peripheries of the six were respectively 94.9, 90.7, 79.2, 67.6, 54.9, and 42.9 millimetres.

It has long been a favourite idea with telegraph engineers that a long-legged electro-magnet in some way possessed a greater "projective" power than a short-legged one; that, in brief, a long-legged magnet could attract an armature at a greater distance from its poles than could a short-legged one made with iron cores of the same section. The reason is not far to seek. To project or drive the magnetic lines across a wide intervening air-gap requires a large magnetising force on account of the great reluctance and the great leakage in such cases. And the great magnetising force cannot be got with short cores, because there is not, with short cores, a sufficient length of iron to receive all the turns of wire that are in such a case essential. The long leg is wanted simply to carry the wire necessary to provide the requisite circulation of current.

We now see how, in designing electro-magnets, the length of the iron core is really determined; it must be long enough to

TABLE IX.—EFFECT OF JOINTS IN WROUGHT IRON BAR  
(NOT COMPRESSED).

H	B				Mean thickness of equivalent air-space for one cut.		Thickness of iron of equivalent reluctance per cut.	
	Solid.	Cut in two.	In four.	In eight.	Centimetres.	Inches.	Centimetres.	Inches.
7.5	8,500	6,900	4,809	2,600	0.0036	0.0014	4	1.57
15	13,400	11,550	8,900	5,550	0.0030	0.0012	2.53	1.00
30	15,350	14,550	12,940	9,800	0.0020	0.0008	1.10	0.433
50	16,400	15,950	15,000	13,300	0.0013	0.0005	0.43	0.169
70	17,100	16,840	16,120	15,200	0.0009	0.0004	0.22	0.087

allow of the winding upon it of the wire which, without overheating, will carry the ampère turns of exciting current which will suffice to force the requisite number of magnetic lines (allowing for leakage) across the reluctances in the useful path. We shall come back to this matter after we have settled the mode of calculating the quantity of wire that is required.

Being now in a position to calculate the additional magnetising power required for forcing magnetic lines across an air gap, we are prepared to discuss a matter that has been so far neglected, namely, the effect on the reluctance of the magnetic circuit, of joints in the iron. Horse-shoe electro-magnets are not always made of one piece of iron bent round. They are often made, like fig. 11, of two straight cores shouldered and screwed, or rivetted into a yoke. It is a matter purely for experiment to determine how far a transverse plane of section across the iron obstructs the flow of magnetic lines. Armatures, when in contact with the cores, are never in perfect contact, otherwise they would cohere without the application of any magnetising force; they are only in imperfect contact, and the joint offers a considerable magnetic reluctance. This matter has been examined by Prof. J. J. Thomson and Mr. Newall, in the Cambridge Philosophical Society's Proceedings, in 1887; and recently more fully by Prof. Ewing, whose researches are published in the *Philosophical Magazine* for September, 1888. Ewing not only tried the effect of cutting and of facing up with true plane surfaces, but used

different magnetising forces, and also applied various external pressures to the joint. For our present purpose we need not enter into the questions of external pressures, but will summarise the results which Ewing found when his bar of wrought iron was cut across by section planes, first into two pieces, then into four, then into eight. The apparent permeability of the bar was reduced at every cut.

(To be continued.)

## NEW PATENTS—1890.

16264. "Improvements in electro-motors and dynamo-machines." H. CHITTY. Dated October 13.

16272. "Improvements in or appertaining to globe or shade holders for incandescent electric lamps, in part applicable to other lamps." R. L. B. RATHBONE. Dated October 13.

16279. "Improvements in the process and apparatus for electrical casting of metals." N. SLAWIANOFF. Dated October 13.

16322. "Improvements in insulating cells for electric batteries." S. C. C. CURRIE. Dated October 14. (Complete.)

16415. "Improvements in methods of and apparatus for utilizing electricity in the formation of sheet metal articles." M. W. DEWEY. Dated October 15. (Complete.)

16472. "A new or improved automatic coin freed apparatus for giving electric shocks." B. J. STACEY. Dated October 16.

16534. "New or improved electrical priming or electrical frictional priming screw plugs." A. LONGSDON. Dated October 17. (Complete.)

## ABSTRACTS

### OF PUBLISHED SPECIFICATIONS 1889.

13960. "Improvements in and relating to apparatus for measuring electric currents and for weighing bodies or substances." A. L. SHEPARD. Dated September 4. 8d. The operation of the apparatus is as follows:—The speed of an electro-motor is so regulated that at any moment the pull of a centrifugal governor equal to the pull of the current being measured. Any increase of the said current will cause a coil upon the extremity of a beam or balance lever to approach the coil or magnet in the said circuit, and thus lower or depress the extremity of the said beam or balance lever carrying the said coil, and consequently raise or elevate the other extremity thereof, and complete the circuit to the electromotor. The speed of the latter will then be increased so that the arms carrying the balls of the governor will fly outwards by centrifugal force, and act upon the other extremity of the said beam or balance lever, so as to draw down or depress the same, and cause the said beam or balance lever to resume its normal position of equilibrium. 6 claims.

14113. "Improvements in switches for electrical propulsion purposes." M. IMMISCH. Dated September 7. 11d. Consists in the employment of a make and break lever, which is so combined with the switches that they can only be shifted after the make and break lever has been first moved so as to break the circuit. 6 claims.

14114. "Improved switch for electrical tramcars." M. IMMISCH. Dated September 7. 11d. The switch ensures the locking of the parts for effecting the necessary changes in any position to which they have been shifted, that is to say, on one side or other of a central position, or in the central position, when the circuit is broken. 2 claims.

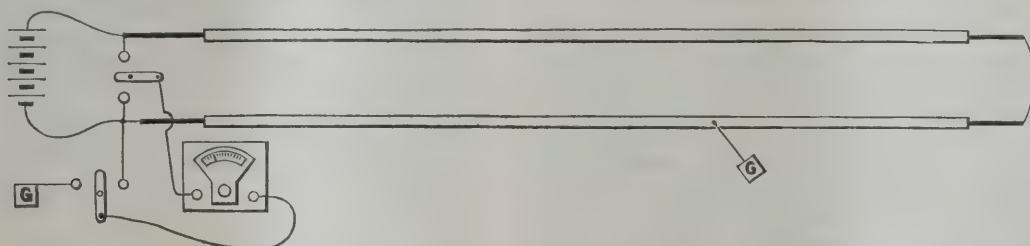
14447. "Improvements in or appertaining to electric or cable-propelled rail or tramway cars, and to brake mechanism therefor, partly applicable to other vehicles." W. P. THOMPSON. (A communication from abroad by S. A. Bemis and L. Pfingst, of America.) Dated September 13. 8d. Particularly relates to improved means for mounting and spring-supporting the car body on the trucks, to improvements in means for hanging the motor when used in connection with the truck, from what is termed the yoke frame, whereby it may be advantageously supported for its most efficient operation; it further relates to an improved construction of the yoke frame for the proper supporting of the brake mechanism, whereby said mechanism is independent of the car body, and will not be affected by the bounding motion thereof; it further relates to brake devices for the trucks of cars of the above-named description having such a construction and arrangement that the space between the car wheel axles of the truck which is required for the electric motor or motors, or for a grip mechanism in case the truck is used for a cable car, is not encumbered inconveniently with any of the brake-operating mechanism; the invention further relates to an improved shoe and connection for the bracing or trussing parts between the truck and the sill of the car. 9 claims.

15230. "Improvements in electric batteries." Sir WILLIAM VAVASOUR. Dated September 27. 1s. 8d. The inventor provides a porous pot, or a partially porous cell, containing or surrounding one of the electrodes of the battery; this porous pot, or partially porous cell, is closed or cemented up with the electrode therein, but

having a connection with the electrode passing through, and provided with inlet or outlet passage or passages for the liquid under pressure. The other electrode or electrodes is or are placed outside the porous pot or partially porous cell. The exciting or opposing liquid is forced by pressure through the porous pot, and the invention being applicable to single or double fluid batteries. 4 claims.

15402. "Improvements in or relating to alternate current electric distribution." W. P. THOMPSON. (A communication from abroad by G. Westinghouse, jun., of Pittsburg. Dated October 1. 8d. Claims:—1. The combination with a circuit supplied by alternating electric currents, of two or more electric converters having their primary coils connected in series in said circuit, and an incandescent electric lamp or other translating device connected in the secondary circuit of each converter, the coils of the converter being so proportioned to the mass of iron in the corresponding cores that, upon the interruption of the circuit through any lamp, a normal current is allowed to pass through the other converters by reason of the high magnetic saturation of the core of the corresponding converter. 2. In a series system of secondary distribution, a converter so proportioned that the self-induction of its primary with open secondary is the equivalent of the resistance of the translating devices normally on the secondary circuit. 3. In a series system of electrical secondary distribution, converters having their primary coils so proportioned that the inductive opposition to the current is approximately the same when the secondary is open as when the secondary is closed through its normal circuit.

15449. "Improvements in electrical cables." W. T. GLOVER. Dated October 1. 6d. The inventor uses either a solid wire or strip or a strand of fine wires or strips as a conductor, and this conductor he insulates, and around this insulation he places an equivalent to the core in the shape of fine wires or strips, and he insulates these if desired. He then lays the requisite number of conductors so prepared into the cable, encasing the cable in insulating and protecting material if desired. 1 claim.



15769. "Apparatus for measuring and recording electric currents." Sir W. THOMSON. Dated October 8. 11d. Claims:—1. The instrument for measuring and recording electric currents, substantially as described and shown on the drawings. 2. In an instrument for measuring and recording electric currents by different positions of an indicator, the use of two bars attached to the indicator at right angles to one another, carrying adjustable weights for varying and adjusting the sensibility and zero of the instrument. 3. In an instrument for measuring and recording electric currents, the combination of an indicator and recorder with a cam caused to turn at a uniform speed; the recorder coming in contact with the cam once in each revolution, and remaining in contact for a longer or shorter time according to the strength of current, and recording the amount of current while in contact with the cam either by a trace on a revolving drum or by a train of counting wheel work, or by both simultaneously, substantially as described. 4. In an instrument for measuring and recording electric currents, the use of a pendulum or spring for controlling the motions of the indicator by touching it through part of its range.

15968. "Improvements in insulating supports for underground electrical conductors." W. C. JOHNSON and S. E. PHILLIPS. Dated October 10. 6d. Claims:—1. Supporting electrical conductors in underground troughs or channels by means of insulating supports having receptacles containing an insulating liquid so arranged as to effect perfect insulation between that part of the support to which the conductor is attached, and that part which is connected to the trough or channel, substantially as described. 2. The use for supporting electrical conductors in underground troughs or channels of insulating supports, constructing substantially as herein described with reference to the drawings, wherein a receptacle or cup-shaped insulator, containing an insulating liquid, is so combined with the supports for the conductors as to effectually insulate the support of the conductor from the part of the insulator connected to the trough or channel.

16599. "Improvements in and relating to electric date and time stamps." C. ADAMS-RANDALL. Dated October 21. 1s. 1d. Has for its main object the combination of number-printing apparatus with electric date and time printing apparatus. 5 claims.

16697. "Improvements in electro-dynamic machines." O. T. BLATHY. Dated October 22. 11d. Claims:—1. An electro-dynamic machine, consisting of a combined alternately acting transformer and motor, having two alternate current magnetic fields (or groups of these) separate from and independent of one another, the phases of which are displaced from one another, and

of a revolving armature with coils closed upon themselves, acted upon by the two magnetic fields or groups of fields, at different parts of its surface and revolution, substantially as set forth. 2. An electro-dynamic machine, such as is referred to in claim 1, having two field magnets, or groups of these, placed at an angle to one another, and an armature with its coils straight, substantially as set forth. 3. An electro-dynamic machine, such as is referred to in claim 1, having two parallel fields, or groups of these, and an armature with its coils made in two parts, the one part at an angle to the other, substantially as set forth.

## CORRESPONDENCE.

### Telephone Switchboards.

In reply to your correspondent "Z." in last week's REVIEW, we should be glad to show him one of the switchboards in question in operation, and give full information at our London office, 11, Queen Victoria Street.

Telegraph Mfg. Co. Ltd.

November 5th, 1890.

### A Speedy Method of Localising Defects in an Electric Lighting Cable.

Referring to the above article which appeared in your issue of October 10th, I submit the following, as it may contain some merit, there being less apparatus necessary.

Attach the battery to the two free ends of the cable the farther ends being connected as were shown.

With a sensitive voltmeter grounded, take the P.D. of X, calling it V, then take a reading of the remaining section, calling it V', the equation will be

$$X : 900 - X :: V : V'$$

or

$$X = \frac{(900) V}{V + V'}$$

A simpler method would be to take the total P.D., calling it V, then the P.D. of X calling it V', this formula will then be

$$X = \frac{V' (900)}{V}$$

The above occurred to me while perusing the article, and while original with me at the moment, doubtless have been used by others with various modifications. Still hoping that they may be of use to some, I remain

Osborn P. Loomis.

Brooklyn, N.Y., U.S.A., October 22nd, 1890.

### Rule for Electric Bell and Alarm Wiring.

In the fitting of electric bells, signals, fire and burglar alarms, &c., and more especially in repairs, renewals, or additions, it is of great importance to be able to distinguish "battery wires"—i.e., wires leading direct from or to the battery—from "connecting wires," i.e., wires running between pushes and indicators, indicators and bells, alarms and bells, &c.

I have devised a rule (see p. 56 "Practical Electrical Notes," 2nd Ed.: Spon), the adoption of which enables "connecting wires" to be distinguished at a glance from "battery wires," and, what is more, "+" battery wires" and "− battery wires" are clearly indicated.

*My rule is as follows:—*

"All wires leading from the + pole of the battery to any push, &c., should be of a plain bright colour (say white, yellow, or red); all wires running between apparatus—connecting wires—should have a covering in which two or more colours are blended; and all wires leading direct back to the battery should be of a plain dark colour, preferably black."

The adoption of this rule by electric bell fitters would, I beg to suggest, save much valuable time which is now wasted in what is generally termed "testing."

W. Perren Maycock, A.M. Inst. E.E.

November 3rd, 1890.

### The Elmore Copper Process.

Owing to my absence abroad, I have been unable to answer earlier the questions put by you in your leader of the 17th inst.

I wish, however, now, without troubling you or your readers with any fuller details of the Elmore process than I have given in your own and other publications, to draw attention to the following errors in your articles of the 17th and 24th inst.

1. Your calculation of the current necessary to deposit 20 tons of copper per week is practically ridiculous.

2. The resistance of "the bath," founded upon this purely imaginary current is equally ridiculous.

3. Your deduction as to the necessary size of tanks involves a like absurdity.

4. The figure of current density quoted by you from Mr. J. T. Sprague is more than double of what is possible in ordinary commercial depositing, with anything like good results.

This point is fully entered into in M. Fontaine's book from which you have quoted. The current density, therefore, which is feasible with the Elmore process being about three times that possible in ordinary work, presents an advantage of no small importance.

5. The assumption by you that the price of a horsepower is about £10 per annum—the week being 60 hours—is entirely inapplicable to the case considered by you, because—

(a) A week in an electro-depositing factory averages about 156 hours in place of 60 hours.

(b) A factory of such a kind is not set up (as suggested by you) in a city where floor space is expensive.

(c). In a city coal is not to be obtained delivered free at 8s. 6d. per ton as it is at present in the Elmore factory near Leeds.

(d.) In the case of an industry in which power forms a large proportion of the working expenses, every attention is paid to reducing the cost of the power by the use of suitable engines and power-saving apparatus.

I am only surprised that you should have dared to estimate the cost of electrical deposition on an assumption so opposed to the experience of engineers.

6. Even if the cost of power were such as you have assumed it to be, the quality of the articles produced and the small amount of labour required would still leave a very large profit to the company for depositing copper articles only, and it should be remembered that copper is only one of the metals to which the process can be applied.

I would ask you how can you reconcile the figures of cost given by you in a table on page 479, where the average cost of producing a ton of refined copper is given at about £12 with the fact that electrolytically refined copper can be bought in the open market at a price which would thus entail upon the manufacturer a dead loss of over 30 per cent.?

The value of the various figures given by you may be fairly gauged by this sample.

If any doubt exists in the minds of yourselves or

your readers on this point, a moment's enquiry of any installer of electrolytic plant will confirm the truth of my remarks.

7. You assume that the value of the Elmore wire process can only be due to the probability of it commanding a higher price.

This is entirely incorrect, and I believe that the company can show a very handsome profit in this department, even at the same price as wire of not more than 98 per cent. conductivity, which is the usual quality guaranteed and not 96 per cent. as quoted by you.

8. In opposition to your calculations we may safely put the reports of the various eminent men who have examined and tested the process, and, in addition to these (which have been published), I may add that the English calculations and results have been quite recently checked and verified with great care by competent French engineers who have visited the works at Leeds, and, after making their tests, have given a certificate as to the correctness of the cost of manufacture and the quality of the articles which you on your own responsibility, and without having seen the process, have thought well to deride.

I have selected the above eight points with a wish to make my letter as short as possible, and in justice to the Elmore Company, I trust that if I am incorrect in any of my statements, you will publicly make the same known, but if not it will only be left for your readers to conclude that you have made an unwarrantable attack upon a new industry, without such knowledge of the matter as alone could justify you in doing so.

I make no comment upon your high principled suggestion as to how persons might successfully steal the ideas of the inventors. So far as the Elmore patents are concerned, I have no doubt that the company will be perfectly ready to meet any such attempts, and to put the infringer through what you seem desirous that the patents should undergo, viz., the fire of the Court.

W. Stepney Rawson.

October 29th, 1890.

### The Lane-Fox Patents.

I willingly accept the challenge to me in your last article on my patents.

Stated briefly, and stripped of all garnishments, the following are the chief arguments which you invite me to overthrow:

1. My inventions are dependent upon the working of Ohm's law. I am not the discoverer of this law; *ergo*, there is nothing new in my inventions.

2. An arrangement of parts forming a novel combination does not constitute a patentable invention, "the parts themselves being the patentable matter, and not their rearrangement."

3. The use of secondary batteries as *reservoirs* of electrical energy does not imply or include their intermittent use (as a *reserve*), but only their constant use as a "simultaneous" accompaniment to the primary source of energy.

4. Although primary batteries are unsuitable for the maintenance of a constant potential (and therefore for electric lighting); yet inasmuch as the same general law governs the electric currents generated by all sources of dynamic electricity, a vague proposal for the utilisation of primary batteries for electric lighting constitutes an anticipation of my system in which they are *not* used.

I believe the mere statement of these weighty propositions, in all their naked simplicity, will carry (to most minds) their own refutation. I leave it to you to correct me if the above statement does not fairly represent your main arguments.

In order, however, to comply more literally with your request for a further *explanation*, I now offer a few more remarks on each point *seriatim*.

1. This affects the novelty of my system of distribution. Now I maintain that there is an important dif-

ference—a difference in *kind*, not merely in *degree* or in *detail*—between my system and the arrangements and projects which you and others have compared with it. The object I had in view was essentially different to that of previous electricians working in the same field. Their objects fall under two headings, namely :

(a) The more effective utilisation of the current in a circuit, from whatever source, treated as a fixed quantity by “dividing” or “subdividing” it.

(b) Obtaining the “maximum effect” from the generating source, as in the case of batteries, by arranging the cells for “quantity” or for “tension” as required.

My main object was to obtain *constancy of the available potential at any point irrespective of the total quantity of current flowing*.

You mentioned Werdermann as a possible anticipator of my system of distribution, but a reference to his patent No. 2,477 of 1878 shows clearly that neither did he contemplate the combination of high resistance incandescence lamps constructed of a continuous “luminous bridge,” with the use of secondary batteries as reservoirs, nor had he grasped the root idea of a constant potential *with a varying load*. Indeed, according to his project—for I am not aware that it was ever tried on a practical scale—a constant potential could only be maintained by keeping up, day and night, the full current required to work the total number of lamps in the installation.\*

2. You have here propounded quite a novel doctrine. Fortunately for the owners of a large number (if not the majority) of the most valuable patents, it has not yet been adopted by the Chancery Division, or any other Court that I know of which has jurisdiction in patent cases. But I content myself with referring you on this point to any text-book of English patent law.

3. I have never admitted that the dynamos, accumulators and lamps must *necessarily act simultaneously* in order to work under my system. On the contrary, I expressly state in my leading specification above referred to, that the charging and discharging of the cells may be effected at different times to suit the exigencies of an irregular and intermittent demand (see page 4 of the amended specification No. 3,988\*\* of 1878). I should have thought, however, that even if I had omitted to say so, common sense would suffice to decide that the chief object of a reservoir is just the advantage of employing it when the primary source of supply fails, or is cut off.

4. My answers to the last three objections really cover this also. You say, indeed, that “it is only a question of proportioning batteries to their work,” while you have already admitted that in the case of primary batteries this cannot practically be done. That is to say, no primary batteries at present known can be rendered suitable for maintaining a constant potential difference for electric lighting purposes.

With regard to the main question at present raised, namely, the novelty of my system, while I have been unable to find anything approaching an anticipation, I have been fairly astounded at the universal ignorance both of the system itself and of the principles upon which it is based, which continued to prevail up to the date of its first adoption in practice in 1882. Thus, out of a long article which appeared in the *Fortnightly Review* of February, 1879, reviewing the progress of electric lighting down to that date, Prof. Tyndall devotes about a page and a-half to the distribution of

incandescent electric light according to Edison’s “alleged mode,” but his remarks show clearly that he had no inkling at the time of any system of general supply *with a variable load at a constant potential*; yet this was two months after my own description of my system had been published occupying over a column of the *Times*. He spoke throughout of the “well-known” law by which the current from a certain source may be divided and sub-divided, and compared such a “system” in the first instance, to a river dividing itself round an island or a number of islands, and reuniting itself in “the trunk stream;” while, in the second instance, he makes a somewhat elaborate comparison with the circulation of the blood. (The italics are mine.) Evidently, however, the learned professor had little confidence in the feasibility of this “alleged mode,” for, with prescient sagacity, he concludes this part of his article as follows: “Knowing something of the intricacy of the practical problem, I should certainly prefer seeing it in Mr. Edison’s hands to having it in mine.”

I should be presuming too much upon your patience and courtesy were I to attempt to quote in this letter all the instances which I could adduce, between that date and 1882, of the same all-prevailing ignorance of my invention, (or let me at least say of the system of distribution, &c., I claim as my invention, and which has since that year been the most extensively adopted).

Suffice it to add that, even as late as 1881, at the Society of Telegraph Engineers, elaborate systems were propounded of maintaining constancy of light by a similar device to Werdermann’s, above referred to, that is to say, by substituting equivalent *resistances* for any lamp when not in action.

Having now dealt, I think, pretty exhaustively with the various objections which you have at present made against my claim, let me add a few words from a more personal standpoint. I much regret that anything like animosity should have crept into this controversy, yet I cannot explain the attitude which the trade generally (with a few honourable exceptions) have taken up towards me and my work on any other grounds. I can understand a certain reluctance to pay me or my syndicate royalties which had not been claimed while my patents remained in other hands; it is only human nature to examine such claims very closely before “shelling out.” What I do not understand is that I should be abused and ridiculed for *making* them, as if I were bound, indeed, by the previous inaction of those to whom I had assigned my rights. Surely the patentee of a system has a good right to consider himself entitled to some substantial return from it after it has been employed by nearly the whole electric lighting world? If not, a better reason should at least be given for vilifying him and spurning his claims, than any which has yet been made public.

But what I have been most pained and perplexed at in this connection is that some of those who are now most active in attacking me were actually first introduced into the electric lighting industry through me, having received their early training at my hands. *Et tu, Brute!* I might well exclaim to more than one of these; but, happily, my position is not quite so desperate as poor Caesar’s. It is some of these very individuals who are now trying to get the public to believe that I did little or nothing for the practical development of the system which I am now claiming as my own.

Fortunately, I do not depend on my later patents only for evidence to the contrary. The true history of the whole subject, and the share I had in it, remains yet to be written. One fact only in this connection I may, perhaps, be allowed now to record, and one which will no doubt take most of your readers by surprise. It is this, that the modern “E.P.S.” accumulator was the outcome of my introducing Messrs. Volekmar and Philippart, jun., into this country, and the first commercially-successful storage batteries ever made over here were made with my

\* The late Sir Francis (then Colonel) Bolton, in his first *resumé* of electric lighting patents, read before the Society of Telegraph Engineers, on May 14th, 1879—that is, probably somewhat before the official publication of my leading specification—summarised Werdermann’s patent after referring to his semi-incandescent lamp as follows:—“When a number of lights are joined up in parallel arc, a switch to each is provided, such that when one light is intentionally extinguished, a resistance equal to that of the light is inserted in its place, and the light in the rest of the lamps is unaltered.” This, although incomplete, is a better summary than that which he gave three years and a-half later of my specification No. 3,988, out of which he only selects the *lamps* for notice.

active co-operation at the Brush Company's Portpool Lane works, of which I was the founder and manager.

Regretting that I am obliged to blow my own trumpet to this extent, I am, &c.,

St. G. Lane-Fox

October 4th, 1890.

At a meeting of the Defence Association, formed to resist the claims being made by the Lane-Fox Electrical Company in respect of the Lane-Fox patents, held at the offices of the Kensington and Knightsbridge Electric Lighting Company, Limited, at 148, Brompton Road, the following resolution was passed:—

"That the list of members of this association be closed on Saturday fortnight, November 22nd, and after that date, members of the electrical trade, who, being attacked by the Lane-Fox Electrical Company, are desirous of availing themselves of the benefits of this association, will be required to pay the double fee of £50." Under these circumstances, any members of the trade who wish to join the association, should communicate with me before the above-mentioned date. I may mention for the benefit of those who are not fully acquainted with the steps that have been taken in the matter, that several opinions have been obtained and submitted to counsel by different members of the association, all of which agree in advising that the claims of the Lane-Fox Electrical Company cannot be sustained. Trusting you will be able to insert this in your next issue, as it is most important that it should reach all your readers,

FOR THE DEFENCE ASSOCIATION,

R. S. Erskine, *Hon. Sec.*

November 4th, 1890.

#### The Electro-Deposition of Copper.

Your calculation of the current requisite to deposit 20 tons of copper in 60 hours is (of course) correct. But, for this work, even in this country, the week may be taken as 144 hours at least; so that the current to deposit 20 tons of copper per week would thus be reduced from 287,600 to 118,800 ampères.

I may observe, with all due diffidence, that this large figure of production—over 1,000 tons of manufactured copper per annum—appears to be in excess of any probable demand at the present time, and must therefore be considered as prospective, if not as speculative or gratuitous. Why, M. Roux, at Marseille, has been contenting himself with an output of 89½ tons per annum; whilst the great Norddentoche Affinerie produces but ten times that weight. And these firms only refine; they do not manufacture.

In regard to the current density allowable, this depends almost entirely on the degree of purity of the anodes, upon which are dependent the character of the electrolyte and the extent of the back electromotive force. With the anodes ordinarily used in refining copper, it is not generally safe to go beyond or, indeed, so high as a density of 10 ampères per square foot of anode (or cathode) surface. At the various refineries the density actually varies from about one-fifth to twice this value. In the Elmore electro-deposition process, the anodes would probably be of comparatively very pure copper; and the cathodes, though not plane surfaces, would, from the nature of the process, be in great measure protected against the detrimental effects ordinarily resulting from high current density. A density of over 20 ampères per square foot would no doubt in this case be practicable.

Perhaps the most important consideration in relation to the above-mentioned process, is that of the comparative size of the deposition tanks, dependent upon the resistance between the anode and cathode surfaces. It

appears inevitable that this will be very considerably greater than that which obtains in the electrolytic refining of copper. In the latter process the distance between the anode and cathode surfaces, both in the form of plates, varies from about ½ inch to 4 inches; the most usual distance being about 2 inches. The resistance per square foot of anode varies from 0.0108 to 0.0322 ohm. Without being practically acquainted with the details of the Elmore process, I think I may, nevertheless, safely say that the tank resistance per square foot of anode will, in this case, be much greater, that the consecutive anode surfaces will be much farther apart; that the cathode surface, no longer in the form of a plate, will be disproportionately small (or, in other words, the anode surface will or should be disproportionately large with a view to reduce resistance as much as possible); and that the tanks, for a given output, will be much larger than those in use for the electrolytic refining of copper.

On the other hand, and in conclusion, I may point out that the deposition would probably be effected under an E.M.F. considerably less than one volt. In electrolytic refining, the E.M.F. for each tank in a series varies from 2 to 5 volt; the mean value being 3 volt. In a process where the anodes would be of comparatively pure copper, the E.M.F. should be below this mean value—unless, indeed, such untoward conditions are realised that economy of horse-power becomes impracticable in view of the urgency of reducing expenditure of capital on plant.

Desmond G. FitzGerald.

#### Accumulator Explosions.

It has often occurred to me that the above subject has not received the attention in your columns which it probably deserves. But I have attributed the omission to the exercise of a wise discretion, seeing that the public are so prone to take alarm at every bogey which presents itself, and that in certain quarters a considerable amount of prejudice exists.

Since, however, attention has been called to the subject in a somewhat objectionable manner, perhaps the sooner the public are made acquainted with the real facts, and to what extent danger, if any, really exists, the better.

I may say that for a period extending over five or six years, during which the Great Northern Railway Company have had in use, under my charge, some hundreds of accumulators for both train and stationary lighting, only four cases of explosion have come under my notice, and these were only of a very insignificant character, the damage in each case being confined to the particular cell in question. Three were occasioned by the connecting straps becoming oxidised and breaking off inside the cell just above the surface of the liquid, through the motion of the trains and arcing across, which, of course, ignited the gases. It is needless to state that these were teak lead-lined cells, fitted with lids and vent holes.

The remedy for this seems comparatively simple. Have the connecting lugs or straps made of sufficient strength to resist all possible vibrations, and see that they are properly *burnt*, not tin soldered on. Also, where possible, duplicate them; finally, the connections from cell to cell should be made by a separate flexible connector, and not simply by means of a bolt through the two adjoining straps.

The fourth case was occasioned by the carelessness of a workman holding a lighted match over the cell while charging; which, however, was against orders, as the usual practice is to use a small glow lamp, with the globe whitened or silvered on one side so as to reflect the light into the cell.

In conclusion, if proper care were exercised in the manufacture, setting up and management of accumulators, explosions would be almost impossible.

F. W. Cooke.

November 3rd, 1890.

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## ELECTRIC RAILWAY ENGINEERING.

CONSIDERING the rapidity with which electric railways were constructed, and the almost entire absence of precedent and experience, it is not to be wondered at that breakdowns on American lines have been frequent and repair bills in many cases rather heavy. During the great "boom" it was necessary to get through the work quickly, in order to satisfy the enormous demand upon two or three companies then in existence, none of which had much practical experience in railway work. New men had to be trained in the space of a few weeks, and sometimes only days, to take charge of the entire plant and equipment of a tram line, taxing to the utmost the mental and physical resources of both the trained and the trainers.

It speaks well of the indomitable energy and perseverance of Americans that they have been able, under most trying circumstances, to keep up a good reputation for electric traction—in fact, to lay the foundation for a gigantic new industry. It was not to be wondered at that motors, gearing, switches, lines, and insulation broke down with frequency, but the surprising part was that the men in charge did not break down themselves. Many a man possessed of self-esteem, and sufficient regard for the reputation of his employers, could tell of anxious days and wearisome nights devoted to hasty repairs, discovery of defects, and schemes for remedies. These men had a complex set of duties and cares. Besides keeping things going with the outward appearance as if nothing had happened, whilst hourly accidents did occur, they endeavoured to show that electric traction is not only better, but also cheaper than any other kind of traction. The eyes of the sceptical public were ever upon them; their work was eminently a public one, and well they did it so far. One by one improvements were suggested and acted upon, and we can see by recent publications that they are not now afraid to discuss publicly certain defects, with a view of getting sug-

gestions for remedies. Rules and specifications are being framed for purposes of future work, with the express purpose of avoiding all the past errors and thus to insure permanent success.

The "General Instructions for Overhead Line Construction for Electric Railways," issued by the Westinghouse Electric Manufacturing Company are a timely and sensible innovation, which deserve imitation in other branches of this industry. We shall reprint these, feeling certain that they will interest those readers who follow up the progress of electric traction. The methods of connecting ground wires, the best kinds of poles and how to plant them, together with overhead wires and fixtures are fully described. No doubt there are differences of opinion as to the best methods of doing these things, but if these rules are followed, little difficulty should be experienced in maintaining the line in good working condition. Perhaps at some future date other firms with large experience will frame rules or instructions for the proper construction and maintenance of other equally, if not more important, parts of electric railways, especially with details appertaining to the cars themselves.

## THE TAIL OF A LAME FOX.

(*Very much after Æsop.*)

A MODERN fabulist, who, until now, has evidently mistaken his vocation in life, has sent us the following:—

Once upon a time, an old Farmer named Moses Gee was walking in his poultry-yard, when he overheard an animated discussion between a goose, a Swan, and a Fox, as to the ownership of some eggs. The goose said they were hers, because they were golden; the Swan said they were hers because they glowed so brightly; and the Fox said they were his because they were laid on the ground, and as he owned the "earth" they must be his. But the birds replied, "We live on the water, in the old dam, and the neighbouring streams,

and, though you may claim the earth, that has nothing to do with us." "Oh!" said the Fox, triumphantly, "my family has burrowed for years in the ground, and currents of water now run through these tunnels into the reservoir that I first thought of." "But did you make the reservoir? And what about the old pump that feeds the reservoir—is that yours also?" "Well—yes—nearly," said the Fox, "For, as I claim the earth, surely the streams, and the dam, and the pump must be mine." The birds were silent; but a small, newly-fledged Drake came forward, and said he believed the Fox was right, for he knew much about reservoirs. He had been nearly choked in one, there was so much mud and weeds, and he would have been drowned had not a kindly frost come and frozen the water. This pleased the Fox, and he whispered something to the Drake about giving him part of the earth, when he got it. The Farmer, who heard all this, now noticed for the first time that the Fox was lame and had lost his Brush. The Fox, observing this, seemed embarrassed, and said, "I know I am a poor lame-Fox, and have lost my Brush, but in this you ought to pity me." The Farmer replied, "I would have pitied you, but for the arrogant claims you made just now. But where did you lose your tail?" The Fox sighed, and said something about his Webb-footed friends, who had made a sell on him. Here he became pensive; then looked angrily at the goose and the Swan, and said he had nearly learned to lay eggs himself once, light ones that would float in the currents from the reservoir. "Oh!" said the birds, "The idea of a fox laying eggs. Why, we could not lay such nice ones but for our vegetable diet of bamboo and cotton seed, and a Fox cannot eat that." At the mention of eating, the Fox looked hungrily at the little Drake, who ran away, saying he did not want to be eaten, and the Fox might keep his "earth" to himself. There was then a great commotion in the farmyard, and Moses Gee, the farmer, said, "Birds, go on and lay your eggs. The Fox is lame. He cannot hurt you: and as to his claim, all the farm, and stream, and reservoir, were mine before any of you were born, and you are all free to do as you please." At this the Fox ran away, and they all lived happily ever after.

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## THE CENTRAL STATION AS AN INVESTMENT.

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IT is evident that the electric lighting business has taken a firm hold as an industry of the world, and that the supply of current for motive purposes will be in increasing demand. Even in this country, the requirements of the public have outgrown the power of private firms to deal with, so that it has been imperative to form large corporations with immense capital to grapple with the task. Central stations have been erected and fitted in many parts of London, from whence the demand for the electric cur-

rent can be met. Districts have been assigned to the supply companies, and the town mapped out in a similar manner to what existed formerly with the various gas companies, before these latter were consolidated into two huge corporations. The question now arises, Will these stations pay? According to Mr. B. E. Sunny (who read a paper before the Chicago Electric Club meeting on October 20th last), that will depend on good engineering, as the whole secret of dividend-paying enterprises is in their ability to run reliably, every day and every year, without subjecting the machinery to excessive and abnormal demands, and in the avoidance of rebuilding, or abandoning original investments. The plant up to the point of normal and safe output should be fully employed, as well by day as by night; it is the duty of the management, therefore, to endeavour to utilise the machinery during the day in driving motors or charging accumulators, or in any other way that will bring grist to the mill; further the price at which the electric current can be produced, and that at which it can be sold, leave a margin of profit that ought to be satisfactory.

Now, commercially, the business may be considered a success, from the fact that it is ever increasing. How then does its record read from the investor's standpoint? Can it be reckoned on the same footing with gas-works, water-works, or railways as a dividend producer? Most decidedly it can, and perhaps no people recognise the future of electric lighting more than the gas companies themselves. The *American Gas Directory* states that the gas companies are operating 32,000 arc lights and 140,000 incandescents. In one year these companies have increased their ownership in electric lights nearly 50 per cent., thus showing their belief in the earning power and permanency of the electric light. Hitherto, the ratio of expansion of business has been put much too low; in consequence, stations have been built on far too small a scale, necessitating, after perhaps only a couple of years, an entire reconstruction of premises and plant to meet the ever-growing demand for electric lighting. Cheap and scratch plants will never pay a dividend in the long run. To be profitable, an installation should be furnished with standard types of engines, dynamos, and apparatus that are not likely to become old-fashioned for many years to come.

By not, at the outset, building a station on a plot of sufficient area, as patrons increase the plant has to be added to until the place is crammed in every corner with a perfect chaos of machinery, and presents what Mr. Sunny concisely calls an exhibition of engineering gymnastics. This kind of station is a financial success, working always at its maximum output, until the demand exceeds the supply, and it becomes necessary to rebuild. The rebuilding means, in many cases, selling off the old machinery at an enormous sacrifice, and the complete loss of all investment in foundations, &c. To prevent such loss in the future, would it not be better to build the majority of central stations on such a scale as will meet the anticipated requirements of electric supply at the end of 20 or 30 years?

Mechanical  
Engineering on Electric  
Tramways.

Mr. A. RECKENZAUN'S paper on "Electric Locomotion," read before the Society of Arts in April, 1887, was probably the most complete *exposé* of the state of the art at that date; therein the subject was considered mostly from a mechanical engineer's standpoint, great care being taken in revealing the advantages or disadvantages of certain mechanical details. It was shown that the spur gearing on certain continental electric cars had worn out in a remarkably short space of time, and that the engineers attached to these lines were puzzling their brains over the best forms of gearing for electric cars. Six months later Mr. Reckenzaun read another paper entitled "Electric street cars, with special reference to methods of gearing," before the American Institute of Electrical Engineers, which evoked an interesting discussion and a variety of opinions. That the problem of the mechanical transmission of power between the motor and axle of a tramcar is still a long way off its solution is evidenced by the report of Dr. W. L. Allen presented to the recent Convention at Buffalo. On four Sprague cars, each running 90 miles a day, there were worn out, within six months ending October 1st, 1890, 14 pinions, 6 spur wheels and 26 bearings of various kinds. On one of the Thomson-Houston electric railways, running 150 to 200 cars there occurred 158 cases of disablement, from purely mechanical reasons, during 14 consecutive days. This would point to the fact that mechanical engineering on electric railways offers a wide field for research and improvement. There are, on an average, six cars disabled mechanically to one electrically. Altogether, the figures are appalling, and we do not wonder that Messrs. Mather & Platt preferred to drive the axles of the City and South London locomotives direct, although, in this case, difficulties of another kind may become apparent, since the acute vibrations of the driving axles are communicated direct to the armature. In the case of tramcars it is most difficult to apply motors of sufficiently slow speed, and gearing of some sort has to be used.

Industrialism.

IN Mr. Esson's presidential address on Industrialism to the Old Students' Association, our readers will find a very able and interesting historical sketch of this important subject from the earliest to the present time. He makes a vigorous onslaught on socialism, State or other; and expresses a decided opinion that what is best in our industrial system is the result of individual effort. His statement, based on personal experience, that the working classes in this country spend from 15 to 20 per cent. of their earnings on beer and tobacco, gives one a somewhat startling idea of the improvidence of the British workman. We think, however, that Mr. Esson overestimates the effect of Poor Laws in encouraging improvidence, since, according to recent statistics, considerably less than one-tenth of the poorest class in London avail themselves of State relief. Mr. Esson thinks that all changes in our industrial system are the result of evolution; the present system with all its defects being the best that the average human nature is capable of. With many other of our most advanced thinkers on this question, he looks upon co-operation as the goal to which we are tending; this being apparently the only practicable means of settling the ruinous contests between capital and labour. Mr. Esson's address, we are sure, will be welcomed by all interested in the labour question, as a carefully weighed statement of the case, by one who has the advantage of

being practically acquainted with the various elements of the problem.

Advertisement—  
fin de Siècle.

THE custom, common to only too many journals, of inserting conspicuous paragraphs, which at first sight appear to be *bonâ fide* items of news, and which upon examination turn out to be advertisements, has become a scandal and a disgrace to present journalism. Our contemporary, the *Electrician*, in a leaderette, calls attention to the case of the *St. James's Gazette*, a journal of some reputation, in whose columns appear, under the disguise of original matter, the advertisements of an "eminent" medical electrician. The paragraph referred to points out that this is a clear case of imposture, and more discreditable to the journal than to the advertiser. We are glad to see the *Electrician* join, although somewhat late in the day, in an attack upon this disreputable phase of journalism.

Render unto Caesar, &c.

IT is sad to see to what extent the manipulators of paste and scissors are allowed to urge on their wild career unchecked. In the last issue of a weekly contemporary entitled the *Practical Engineer*, which, however, belies its name in this instance, we find that famous note culled from the "London Day by Day" columns of the *D.T.*, which has immortalised Earl Poulett and his yacht. If it had given our daily contemporary the credit of originating the wonderful story of accumulator explosions nothing need have been said, but the paste and scissors gentleman has so far forgotten his mission in life that it appears as an editorial note in a technical journal.

Clear Off the Track.

IN a leading article devoted to the opening of the City and South London Railway, one of our contemporaries seems to have gone off at a tangent. Witness the following:—"We very much regret to hear that Messrs. Mather and Platt have contracted to run the trains at 3½d. per train mile for two years. This system has proved disastrous in both electrical and other mechanical tramway work, it has led to all sorts of complications and disputes, and has created antagonism where co-operation is essential. The local authorities themselves have not done so much harm to the development of electric traction as have tramway companies, who have tempted inexperienced inventors to make what they call demonstrations of their systems under this method of contracting at so many pence per car mile." We fail altogether to see any cause for the state of mental perturbation into which the editor of our contemporary has fallen and which has partially obscured his usual clearness of perception. Messrs. Mather and Platt can scarcely be called inexperienced inventors, and if they are satisfied that the power can be supplied at the price named, and the Railway Company accepts these terms, it is difficult to perceive why complications and disputes should crop up. With Dr. Edward Hopkinson's large experience of the Bessbrook and Newry line, Messrs. Mather and Platt are doubtless perfectly justified in the policy they have adopted, for our contemporary seems to forget that the previous electrical work in which "this system has proved disastrous" has always had the accumulator as the unknown quantity in the problem. Moreover, so far as we have been able to judge, the tramway companies have been the tempted, and not the Mephistophelian fiends who lure on misguided inventors to destruction; but, then, perhaps we look at the same things through different coloured glasses.

COMMUNICATIONS FROM AUSTRIA-  
HUNGARY.

[FROM A CORRESPONDENT.]

YOU have already announced the projected electric lighting of the Imperial Palace at Vienna, and the details have since been made known in semi-official circles. The installation, which owes its origin to the decision of the Emperor, will be completed by January 1st, 1891. It will not, however, for the present extend to the apartments of their Majesties, which will not be arranged for this purpose before next summer. There will be put up altogether 4,000 glow lamps, with an illuminating power of 4 to 5 normal candles. They will be introduced in the large reception rooms, consisting of the Hall of Knights, the Ceremonial Saloons, and the apartments for strangers placed behind them; the electric light will also extend to the great Ambassadors' Stairs, the St. Stephen rooms, and a part of the old Imperial Chancery. The large Ceremonial Hall, in which the Court balls are held, will have 1,500 glow lamps. All the old chandeliers, which are at present fitted up for wax candles, will remain, and will serve as mountings for the glow lights, the electric leads being conveyed through wooden pipes well varnished.

The electric lighting of the Royal Hungarian Palace at Buda, which, as I have already informed you, is likewise a decided matter, will not be carried out before next year, since it is feared that the adaptations might not be complete before the date when the Imperial and Royal family will take up their abode in the Buda Palace. Here, also, there will be used 4 to 5 candle glow lamps, about 1,500 in number, and, as in Vienna, they will be mounted like candles in the existing chandeliers.

At Fiume, the International Electric Company is about to erect extensive electric works from which 100 H.P. will be taken by means of alternating current motors for working the newly constructed elevator. The concession granted to the city has already received the sanction of the Municipal General Assembly. But here, also, the gas company is preparing on an equally frivolous pretext with those which I have described to you as having been raised at the Bohemian watering place Teplitz, to contest the right of the town to grant such a concession. I hope shortly to give you very interesting details on this question.

In the little South Hungarian town Karánsebes, the electric works erected by the firm Schmidt and Perlfasser at their own saw mills has come into action, and subscriptions for 500 lamps have already been taken up. This is the first electric works in Hungary for lighting a small provincial town, and has excited a lively interest in the neighbouring towns. It appears very probable that other Hungarian towns will shortly follow the example of Karánsebes.

The firm Müller and Einbeck, recently converted into a joint stock company, has also erected works at Baumgarten, near Vienna, for the manufacture of Tudor accumulators, and is about to open commercial and technical offices in Vienna.

The management of the Royal Hungarian State Railway has resolved to introduce the electric light in their trains, and in the first place in the express trains. At present a train of eight carriages is being experimentally arranged for the electric light, and the results obtained will be accepted as decisive for the introduction of this light on long-distance trains. The experiment will be carried out with accumulators supplied by the firm Müller and Einbeck.

**The Electric Light in Leamington.**—A controversy is in progress between the Corporation and Messrs. Chamberlain and Hookham respecting the quality of the light supplied to the borough. The authorities refuse to pay, and the Birmingham firm demand 5 per cent. on the unpaid account, at the same time stating it is their intention to apply for a provisional order.

A NOVEL COMBINATION ELECTRIC  
SWITCH.

By LIEUT. SAMUEL RODMAN, JUN., U.S.A.

IN presenting the following subject matter, I am led to believe that it may possess sufficient interest and value to warrant at least a passing glance from the readers of the *Electrical World*. Hardly a day passes but some new design in the way of a double or single pole switch is brought out. The one which I have devised, and will describe, is neither, but may better be called a continuous combination switch.

As it possesses certain characteristics different from other switches, I shall first go into a little preliminary detail, in order to make clear its functions and working. Referring to fig. 1, let A represent a strip of metal, and  $b, b', b'', b'''$  and  $b''''$  metallic springs, so arranged that when A is moved up or down in the direction of the arrow, it will successively touch the metallic springs,  $b$  to  $b''''$ , until it reaches a position indicated by the dotted line enclosing  $A'$ , when it will touch all five of the springs,  $b, b', b'', b'''$  and  $b''''$ . Move the metallic

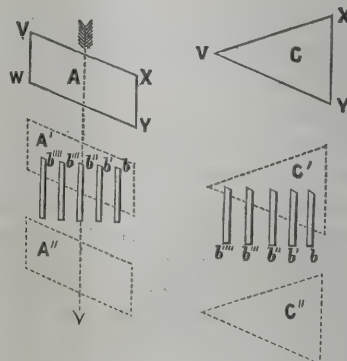


FIG. 1.

FIG. 2.

strip now to the position indicated by the dotted lines enclosing  $A'$ , and it will be seen that it will slide past the metallic springs in the same order that it moved on to them. So, taking the movement in detail, we have the metallic strip first touching the spring,  $b$ ; then  $b$  and  $b'$ ; then  $b, b'$  and  $b''$ ; then  $b, b', b''$  and  $b'''$ ; then  $b, b', b'', b'''$  and  $b''''$ ; then  $b', b'', b'''$  and  $b''''$ ; then  $b'', b'''$  and  $b''''$ ; then  $b'''$ , and finally sliding past all of them.

Referring to fig. 2, let C represent another strip of metal, and  $b, b', b'', b'''$  and  $b''''$ , as above, metallic springs. Move C in the direction of the arrow to positions indicated by the dotted lines enclosing  $C'$  and  $C''$ , and it will be seen that it will successively touch the metallic springs from  $b$  to  $b''''$ , and will slide past them in exactly the reverse order from  $b''''$  to  $b$ . Taking this second example in detail, we have the metallic strip, C, first touching the spring,  $b$ ; then  $b$  and  $b'$ ; then  $b, b'$  and  $b''$ ; then  $b, b', b''$  and  $b'''$ ; then  $b, b', b'', b'''$  and  $b''''$ ; then  $b', b'', b'''$  and  $b''''$ ; then  $b'', b'''$  and  $b''''$ ; then  $b'''$ , and finally sliding past all of them.

By giving different shapes to the metallic piece which slides on and off the springs, other different combinations could be brought about; but the two general cases given will show that for the five springs taken there are nine different combinations of contact between the metallic piece and springs; or taking the more general case, and letting  $n$  represent the number of metallic springs, the different combinations of contact between the metallic piece will be represented by the general expression  $2n-1$ .

For a simple case to show how such an arrangement as I have described will apply as an electrical switch, I will refer to fig. 3, which represents a dynamo, one pole of which is connected to the metallic strip and the other to one terminal of each of a group of five lamps, the other terminal of the lamps being each connected to one of the metallic springs,  $b$  to  $b''''$ , as in fig. 1. Now,

suppose A to be moved in the direction of the arrow head, and, from contact with *b*, lamp C will burn; then, from contact with *b* and *b'*, lamps C and C'; then, from contact with *b*, *b'* and *b''*, lamps C, C' and C'', and so on until A has moved past the springs and no lamps are burning. By this arrangement, then, we have 1, 2, 3, 4, 5, 4, 3, 2, and 1 lamps burning, or, in other words, we have varied the intensity of the light gradually and continuously. The example taken of the continuous gradation of light is presumably the simplest case. Many other applications may be made, substituting for the single lamps different coils of a shunt-wound dynamo or motor, or groups of lamps.

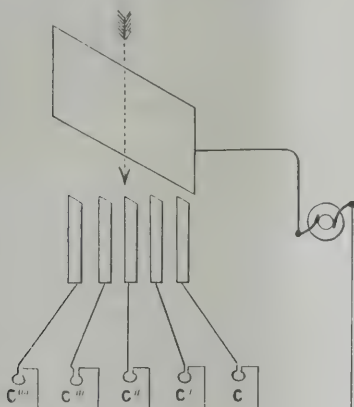


FIG. 3.

The number of metallic springs chosen in the figures is five, but it can readily be seen that by increasing the size of the metallic strip A, fig. 1, and C, fig. 2, almost any number of metallic springs can be accommodated, and also a greater number of circuits controlled continuously and successively.

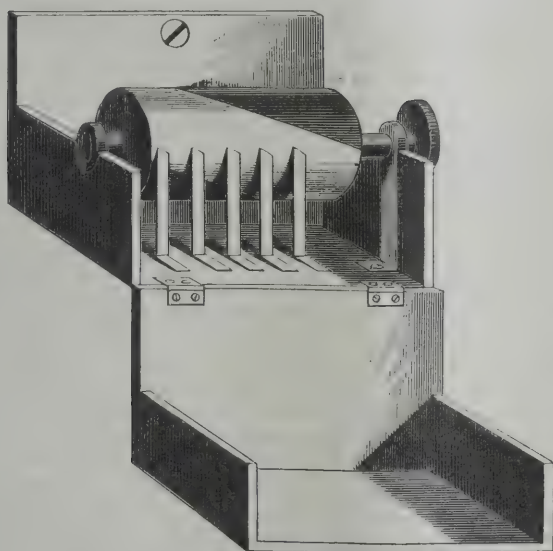


FIG. 4.

As a suggestion to those interested in the subject, I would propose the use of such a switch in connection with a shunt-wound motor on electric cars, in order that the current from the main dynamo may be thrown into the motor coils successively, increasing gradually the number of ampère turns, and possibly overcoming the difficulty and strain experienced in starting a heavily loaded car from a state of rest, and lessening the number of burnt-out armatures. By the use of such a mechanism no resistances are necessary, but the increments of current are supplied successively by a simple mechanical arrangement.

To resolve the mechanism above-described into an electrical switch, I simply make one mechanical change,

and that is, to transform the motion of translation of the metallic piece A, fig. 1, and C, fig. 2, to a motion of rotation about an axis, and the following description of the switch will be sufficient explanation:—

A cylinder of insulating material having a metallic axis is first made. A thin flat metal strip shaped like A, fig. 1, or C, fig. 2, is then cut out and wrapped around the cylinder, the sides V, W and X, Y of A, and the point V and the side X, Y, of C, coinciding with the two opposite circular edges of the cylinder, thus forming a helical plate. The plate is secured to the cylinder by metallic screws which project through to a good contact with the axis. The latter revolves in a metal bed or bushing, and is held firmly by caps. The whole arrangement is set in a box of peculiar construction, as shown in fig. 4. The metallic springs are attached to the bottom of the box, and press firmly against the cylinder. On the under side of the box are binding posts, one to each metallic spring. The terminal of the dynamo is led in through the bottom of the box and screwed to the metallic strip shown on the right side of the box. This strip is maintained in metallic connection with the helical plate on the surface of the cylinder by means of the metallic bushing, axis, and screws connecting the helical plate with the metallic axis. The screw seen at the top of the box is intended to fasten the whole arrangement to the wall. It will be seen that the box can be readily closed and opened without removing it from the wall; also that by taking off the caps over the axis of the cylinder the latter may be removed and the switch thereby rendered inoperative, so that the connection of the wires will not be attended with any danger. I think, at least, it can be claimed that the whole apparatus is very simple for one which combines so many different functions in so small a space.

## THE CIVILIAN ELECTRICIAN IN MODERN WAR.\*

By LIEUT. BRADLEY A. FISKE, U.S.N.

I BEG to propose for your consideration this evening a plan by which, in time of war, all the electrical resources of New York, both in supplies and in men, will become at once available for the defence of the country and the city.

It is well known to all here that electricity has come into use as one of the great factors in warfare, both on sea and shore, not as an adjunct merely, as for lighting ships and forts, but as a vital element in the handling of weapons in actual battle, and in the construction of new instruments which accomplish things heretofore impossible.

I desire to recall to your recollection a few of the most important uses to which electricity is now put in warfare, to indicate some of the probable paths of future development to show that it would be impossible for our regular navy and army to adequately handle the vast electrical work that would have to be instantly done in time of sudden war, and to suggest a plan for coming to their assistance.

The science of electrical engineering is now recognised as one of the most necessary of the practical sciences of the world. It stands out as distinct and defined as the science of medicine, or the science of astronomy. It enters into thousands of the departments of daily life, but into no other department is it used in so various and important ways as in warfare. This is so much the case that the prophecy is sometimes ventured that in the near future nations will fight by electricity. Though this, like all extreme statements, requires modification, yet the number of ways in which electricity has come to be applied within the last eight years is calculated to inspire the liveliest an-

\* A paper read before the N.Y. Electrical Society, October 23rd 1890.

ticipations as to the developments of the next eight years. No vessel pretending to modern equipment goes to sea without a complete electric plant for furnishing light. This light is so much more suited to ship life than any other light that we now wonder that we ever went to sea without it. The electric motor is coming into use for ventilating ships, and it is beginning to be used for training guns and the hoisting to the deck of shot and shell. The best and the most accurate results at target practice are attained when the guns are fired by electricity. Range finders give the gunner constant knowledge of what he must know, *i.e.*, the distance of the enemy. The best means of night signalling, and the one adopted in nearly every navy in the world, is by means of incandescent lights. The electrical search light is almost as much a feature of the equipment of a modern war ship as are her guns and her torpedoes. In the actual use of the Whitehead and Howell torpedoes electricity plays an important part. The telephone is now coming into use for ship work, and will unquestionably supplant the speaking tube, which is acknowledged in all navies to be unsatisfactory. In fact, we find all through modern war ships an increasing use of electricity. The reason is clear. The modern war ship is the most intricate, tremendous and powerful machine existing. In no other equal space can be found so many, so various, and so important kinds of apparatus. Everything must be done which will put her absolutely within the grasp of the captain. She must respond at once to his command, and her whole strength and power must be his, as though she were a part of him. Ensconced in his armoured conning tower he must be the brain of the gigantic body. Electric wires must convey instant tidings to him from her innermost recesses, and electric wires flash back from him the inevitable command. In this way only can a modern ship, no matter how large, how strong, how heavily armoured, or how swift, completely fulfil her mission and be a perfect fighting machine.

What is true of ships is equally true of forts. The power of ships' guns has so increased that it has become necessary to protect shore batteries by iron and steel instead of masonry, as in the days not long gone by, and, in addition, to use disappearing carriages wherever it can be done. Disappearing carriages, as is well known, are so arranged, that the gun disappears below the parapet of the fort when the gun is fired, and remains out of sight and safe during the operation of loading, so that it is exposed only for a short time when it is raised to fire. Now, without the aid of electricity, a very considerable time would elapse, even after the gun was raised, before it could be fired, because the gun would have to be trained in the proper direction and be elevated to the proper degree for propelling its projectile over the distance between it and the enemy. To estimate this distance and make the proper adjustments would entail delay, and would be absolutely impossible if smoke obscured the target, as would be the case a great portion of the time. But electricity, acting through the medium of the position finder, gives the gunners continuous information of the distance and direction of the enemy, no matter how thick the smoke, so that they know exactly what to do before the gun is raised to fire.

Electricity, furthermore, gives the commanding officer complete control of all the different groups of guns and mortars in his fort. Noting the progress of the action from a station aloof from the smoke and noise, he can direct the concentration of as many batteries as he thinks best on one ship, or can disperse the fire as much as circumstances from time to time dictate.

For the handling of the monster apparatus used in forts, the guns, the carriages, the ammunition, electricity is rapidly coming to the front. Some power must be used, since the muscles of men are too weak. Hydraulic power has been used hitherto; but for many purposes electricity has the same advantages over hydraulics that have caused its unprecedented advance in the other departments of engineering throughout the world; while for repelling a night attack from ships,

the search light has been found, by repeated trials in the naval manœuvres abroad, to be simply indispensable to the land defence.

For military service in the field there is not an army in the civilised world that has not its military telegraph service. One great cause of the suddenness and completeness of the German victory in 1870, was the rapid mobilisation of the Prussian army, and its appearance on the frontier ready for battle. Now the splendid efficiency of the telegraph service in the hands of the military authorities made this possible. Nothing is more important in warfare than despatch in moving the enormous bodies of men, of which modern armies are composed, with all their ammunition, equipments, and numberless accessories. To move a quarter of a million men to the frontier in a single day, means a good deal; and to manœuvre so large a body of men with such precision and rapidity that no one division shall have to wait for any other division, simply cannot be done without electricity.

But the most immediate and important use of electricity in the defence of a coast is in the submarine mine or ground torpedo. Defending a harbour with submarine mines is simply carrying out with more or less elaboration a system by which a large number of watertight tanks, each holding from 100 to 1,000 lbs. of gun cotton or other explosive, are anchored in carefully defined positions, and connected by armoured electric cables with protected operating rooms, in which are batteries, measuring instruments, &c. The more complete mines have usually floating above them automatic circuit-closers, in which two contact points are joined together by a passing ship, and thus afford a passage for the electric current to the fuse in the torpedo.

Now these mines are some of them exceedingly large and heavy, and the electrical apparatus, while simple to the mind of a trained electrician, yet must be made and adjusted with great care. The torpedoes as a system must be constructed, laid down, and connected to the operating rooms on shore by long and heavy armoured cables. The operation of practically planting and connecting the necessary submarine mines for New York would be a stupendous undertaking. Kindly bear this in mind until I recur to it again.

We have now seen, after a rough survey of the subject, that electricity has already acquired an acknowledged position in the art of war, and that the uses to which it is put are not trivial ones. Electricity is not used in warfare as a convenience, nor is it a fad of theorists; it fires the guns, it discloses the stealthy approach of the torpedo boat at night, it directs the proper elevation of the guns; in fact, it does good, honest, practical work. But note this point also: in every one of these applications of electricity we have to pay, in one way, for what we get, by studying the ways in which electricity will work for us. We cannot expect electricity to work for us unless we treat her properly. We cannot handle electrical apparatus with carelessness and ignorance, and expect that it will work when we need it. In other words, we find in warfare, as in everything else to which electricity is applied, that electricians are useful. This remark doubtless seems absurdly commonplace, but it is intended to suggest that, in war time, electricians, even civilian electricians, may suddenly become very useful to the Government. A captain of a fine ship might lose an action from simply a lack of knowledge as to some electrical appliance on his part, or on the part of some subordinate; some small accident might break a circuit just at a critical juncture, which might prevent the communication of an order, the receiving of information, or the firing of a torpedo at a crisis; and yet the cause might be such, that a man with even a very slight knowledge could remedy the difficulty in a second by the mere pressure of his finger; but that pressure not being given, the action might be lost, and from that cause alone.

Let us now glance at some of the other uses of electricity to which it would probably be but in case of an attack upon New York. There can be no reasonable doubt that Lay torpedoes, Patrick torpedoes, Sims-

Edison torpedoes, and Halpine-Savage torpedoes would come to the front at once. The enemy's fleet being daily expected off Sandy Hook, we should see the advocates of these systems, under authority of the general government, preparing stations at Coney Island, Sandy Hook, and elsewhere, for the launching of their dreadful missiles against his ironclads. The question of ballooning, both for observation and for the dropping of explosives on his decks, would be taken up at once, and the electrical world would be agitated anew over the question of balloon propulsion by electricity. Electric launches, ranged to carry torpedoes, would be fitted out to noiselessly steal out at night on their errands of destruction. Electric picket boats of smaller size, perhaps, would scout the waters in pursuit of information, or to convey despatches; electric submarine boats would spring into being by the dozen, and, filled with adventurous spirits, would seek the enemy, secure from detection below the surface of the sea, and carrying enough explosives to utterly destroy the proudest war ship of the world.

It will now be apparent that in the case of a sudden war (and most wars are sudden), there will be an immense amount of work to be done in the electrical line alone. Could our regular army and navy do all this work in the time allowed? It is probably known to all here that our regular army and navy are simply a nucleus around which fighting forces could be formed. They are so small as regards both officers and men, that they can barely carry on the work in time of peace, and would be wholly inadequate in time of war. We should not have enough battle ships, monitors, cruisers, or torpedo boats; we should not have enough forts; we should not have enough sailors; we should not have enough infantry; we should not have enough artillery; we should not have enough electricians. Take the single matter of laying out and connecting up the submarine mines in New York harbour. This is an area covering many square miles, in parts of which the mines would be placed at frequent intervals; every mine being accurately secured in its designated place and connected by cable to the operating room, perhaps miles away. The mere labour of constructing, fitting and filling one mine, and afterwards taking it out into the harbour and lowering it into place, with all its connections, is no small task; and what can be said of the task of doing this with hundreds of submarine mines? Then the work of properly arranging the various cable connections, testing apparatus, firing apparatus, &c., necessary for the efficient action of the mines would follow. The Board on Ordnance and Fortifications have designed all the torpedo defences, but they will not be in practical operation, probably, for many years, and a war may come meanwhile. But it is certain that on the outbreak of any war an immense amount of this work would have to be immediately done, because we will never keep the submarine defences of New York harbour on a war footing in time of peace.

The Navy Department would be even more hurried. We should certainly be called upon to commission a great many war ships, and to equip as commerce destroyers a great many merchant steamships; we should have to do all the things that we did on the outbreak of our last war, and in addition, we should be confronted with the necessity of fitting all kinds of fine apparatus, the necessity of fitting electrical appliances of all descriptions, besides securing gun-circles in place with mathematical precision, and of accomplishing all the manifold fine work that is required with the ordnance, navigation and engineering equipment of a war ship of the present day. And as to fitting on merchant ships, who is going to fit them out? This operation requires technical knowledge. Who has it? How many of the merchant steamship captains would be able to install and manage a battery of even Hotchkiss or Driggs-Schroeder guns, or could remedy an accident to either gun or ammunition?

It being apparent that the regular army and navy in event of a sudden war would be unable to handle all the electrical work that would certainly be thrown upon them, I will propose the formation of a corps of

naval and military electricians to assist the regular army and navy in its work. Such a corps might exist in every principal seaport town on the coast; the principal one, of course, being the corps with headquarters in New York. Electricity being now a recognised factor in both naval and military war, and requiring expert electricians for its full development, there would seem to be just as much reason for an electrical corps in the National Guard of the State of New York as for infantry, artillery or cavalry. While the members of this corps would be men of technical knowledge, and while its sphere of usefulness in war would be because of that technical knowledge, it is obvious that the organisation should be a military one, and that with some modifications it should be governed by the same principles as govern all military bodies. Being a military body under the Governor of the State, it could at once become available at the outbreak of war.

It would seem that this corps, like all other corps, should be composed of men of various ranks, subject to various duties. Many kinds of work would have to be done in war, and many kinds of men would be required to do them. On the outbreak of war, certain members would naturally elect duty in the navy; others in the army. The most obvious and immediate employment would doubtless be in the torpedo defence of the harbour, under the direction of the general commanding. And who can doubt the gratification which that general would feel, when suddenly ordered to defend New York Harbour, on finding added to his list of subordinates a hundred or more capable electrical engineers, young, enterprising, accustomed to difficult electrical work, familiar not only with electricity in its technical features, but also acquainted with the electrical people of New York, with its factories, its places of business, and its methods of business. These men would become available in a day, and could be at once set to work in carrying out the details of the vast and complicated system. Their work need not be confined to that purely electrical in character, because every electrical engineer is, by training and of necessity, a mechanic, and every sort of apparatus would be readily understood by him, and a very slight training will make him master of it. Those members volunteering for naval work would be equally useful. The ordnance officer at the Navy Yard would suddenly find himself overwhelmed with a mass of work which he would be utterly unable to carry out without the assistance of some such sort as this. And for the reason that electrical engineers are of necessity mechanics, a great deal of technical work could be entrusted to them, such as the arrangement and fitting of gun carriages, the storage of ammunition, the assembling of guns, &c. Their more immediate and obvious field, however, would be the installation and fitting of electric lights, motors, telegraphs, telephones, and other electrical appliances on board the vessels of war suddenly called into requisition. In the matter of fitting out merchant steamships their usefulness would be at once apparent. The number of regular officers would be found utterly out of proportion to the number of ships; the whole navy would have to undergo an expansion. Only a very few regular officers could be assigned to each vessel; so that the majority of officers would have to be volunteer officers, as was the case in our Civil War. During the first part of the war the command of the different vessels would naturally be intrusted to regular officers leaving the other positions to be filled by volunteers. Now, as the commander of a ship is head of all the departments of a ship, he cannot give much personal attention to one special department. Therefore, the general arrangement and fitting out of all vessels, both regular war ships and merchant steamships, would have to be largely entrusted to volunteers in all that relates to the electric and ordnance equipments. Now, as the work of fitting out ships with electric and ordnance equipments calls for technical knowledge and experience of a high character, it is obvious that a corps of well-trained technical men, such as here suggested, would be more than useful, they would be necessary.

A further field for employment of such a corps in time of war is suggested by the fact that the genius of our people tends towards constant invention and improvement of all sorts of machinery and apparatus, and our history has shown that every war has brought into being many inventions in weapons of defence and offence. Can it be doubted, then, that any future war would produce more such inventions? And in view of the great progress of electrical science since the last war, and in further view of the large number of electricians in New York, can it be doubted that many of these inventions would be electrical in character? Under the stimulus of a national peril, and with the resources of New York at command, it is certain that important and novel warlike applications of electricity would at once spring into being. And while our regular forces of both army and navy were employed on their specific duties, what more natural than that some new Ericsson should arise, and some new "Monitor," or other craft, startle the nations of the world? Therefore, besides the obvious uses to which such a corps as this might be placed, there are other uses, no less important, of inventing, constructing and using weapons of defence, the nature of which we cannot as yet even faintly conceive. And as few heroes of our late war go down to history with more glory than has Ericsson, so, perhaps, our next war may produce some electrician now unknown, whose fame will outlive the ages.

It would seem as if such a corps as this could be formed under existing laws, and that there would be no difficulty in enlisting members. The attractions of the Naval Reserve and of the National Guard seem sufficient to induce a large membership in the different regiments, and there is no reason why membership in an electric regiment should not be equally desirable and confer equal distinction. The qualifications for entrance as regards education and intelligence, would be greater than those for any other regiment, corps or battalion. Its military and naval usefulness would be acknowledged, and its position in all respects would be one of dignity. The larger the membership, the better, provided, of course, that due care be observed in excluding undesirable persons. The whole electrical influence of New York and of the country would be at its back, with all its millions of dollars and its men of world-wide fame; and there is no reason why it should not acquire a national influence. The course of instruction could be readily carried out, embracing the naval and military applications of the purely technical science, with which the members are already familiar, instruction being given by regular navy and army officers detailed for the purpose. This instruction would naturally embrace the construction and care of apparatus. It being presupposed that there are different ranks in this corps, the system of instruction will naturally differ with the different ranks. With the higher ranks, it would naturally embrace the theory and practice of gunnery, navigation, including compasses, and seamanship. Steam engineering would probably not need to be taught, it being assumed that the members require very little instruction in that branch. For the lower ranks the scheme of instruction need not include much more than the handling and care of the different apparatus. On the outbreak of war the members volunteering for the different services could be subjected to certain examinations, and their rank determined by the proficiency exhibited. As to the details of organisation, uniform, &c., these need not be entered into here, as they can obviously be settled at any future time. My only purpose now is to propose to you a plan for meeting an emergency, which may some day arise. I would hazard the suggestion that the corps or battalion should at first include about 250 members, and that it should be officered, uniformed and drilled in much the same ways as the other corps of the National Guard. I would even advocate a certain amount of infantry drill as a means of instilling the military idea. Occasional runs in the torpedo boat *Cushing*, and frequent short trips out to sea for target practice in modern war ships, would be essential. There would be considerable work, but there would be

many compensating social and other advantages. I have ventured with much diffidence to put forward this idea, but earnestly hope that you will think it worthy of earnest consideration. My only excuse for broaching it is that it has been in my mind for many years, that it has been commended by every man to whom I have spoken about it, and that I have been urged to bring it to the attention of the electricians of New York.

### THE PARIS TELEPHONES.

THE new service of telephoned messages began working on the 3rd inst. On the morning of that day, the Administration of Posts and Telegraphs posted up the following notice:—"On and from the 3rd November, 1890, the public is allowed to send telephoned messages to any address included in one of the streets situated between the Seine and the grand boulevards. The price is fixed at 50 centimes per five minutes' occupation of the cabin. The length of occupation is limited to a maximum of ten minutes, when others are awaiting their turn of communication. For the transmission of messages, communication can only be demanded directly by the sender." Thus a telegram can now be telephoned, provided one is within the radius served by the ten telegraphic offices situated between the Place de la Concorde, the Seine, the grand boulevards, the Place de la Bastille, and the Boulevard Henri IV. He can telephone from any point, but only messages for persons living within the above-mentioned radius will be admitted. If this attempt succeeds, it will be successively extended to the rest of Paris, and also to the suburbs.

The following are a few details of the new central telephone office which is being built on land between the Rues Gutenberg, Jean Jacques Rousseau, and du Louvre, with its principal frontage to the Rue Gutenberg. The ground floor will serve as a standing place for the vehicles of the postal authorities. On each of the four floors will be found a large hall, 60 metres long by 10 wide. In these halls will be placed the apparatus, which will enter the building in the cellar through the sewers, and will be distributed between the four floors, which will share the telephonic transmissions and receptions of the four zones of Paris.

Our Parisian contemporaries keep up a running fire of comment, sarcastic and otherwise, on the telephone working in Paris. One of them, for instance, relieves itself as follows:—"The service of pneumatic tubes is decidedly as defective as that of the telephones. It is thus that a *carte-télégramme* registered at 11.35 on Friday morning at the Bourse office, was delivered at five minutes past four in the afternoon at Montrouge. This fact is noticeable at a time when the trial of telephoned messages is going to call upon the deplorable services of the telephones and the pneumatic tubes to lend assistance.

There has also appeared in the *Journal Officiel* a decree which creates, for the night, a conversation tariff at reduced price in the interurban correspondence service. This tariff is fixed per unit of telephonic conversation, and per 100 kilomètres or fraction of 100 kilomètres of distance between the points joined by the telephone line, at 30 centimes for ordinary conversations, and at 20 centimes for conversations by subscriptions. The subscription includes the daily use and at a fixed hour for a five minutes' conversation for a circuit specially designed, the minimum duration being one month. The subscribers obtain communication at the precise moment provided there is not a conversation on between two other persons. The time not used at one conversation cannot be carried over to another, save and except the non-use be due to an interruption of the service. After a first interruption of the service of 24 hours, there is to be returned to the subscriber, for each further period of 24 hours, a thirtieth

of the amount of the subscription. The circuits over which this reduced tariff is to be applied and the hours during which the conversations may take place under this decree will be determined by ministerial warrant.

### STREET RAILWAY MEN AT BUFFALO.

ELECTRICAL engineers have again been enthusiastic over the cordial reception they received from the American Street Railway Association, which held its ninth annual meeting at Buffalo, N.Y., during the week ending October 17th. Mr. Thomas Lowry presided over an assembly of nearly 500 gentlemen interested in every branch of street railway business, and he opened the proceedings with a pithy address, setting forth the general progress of tramway building and tramway working in the United States. Mr. Lowry pointed out that in the smaller cities electricity is generally being adopted, and there are already about 1,600 miles of electric railways in operation; but municipal corporations in the large cities, with the exception of Boston, are slow to grant new privileges. He hoped, however, that when the people understand clearly the great benefits of rapid transit, by electricity or other improved motive power over horses, they will demand that their city authorities grant such rights as will enable street railway companies to operate by the most approved methods. From these remarks of the President one would naturally infer that in large cities electric traction *per se* has been objected to, but we know it as a fact that such is not the case, and that systems devoid of overhead conductors have actually been encouraged by the authorities who are merely anxious to get rid of overhead wires in general.

The first communication was a "Report on Electric Motive Power Technically Considered," by Dr. W. L. Allen, which fully discusses the various electrical and engineering details of an electrical railway. This is a thoroughly practical paper, showing up the defects which have been made manifest during prolonged operation, and it suggests sensible remedies in several instances. The author gives a list of breakdowns which occurred at various periods on one of the Thomson-Houston roads, and he shows that most of these were of a mechanical nature. During 14 consecutive days in July last, out of 150 to 200 cars in operation, 26 were disabled through electrical defects, and 158 breakdowns of a mechanical nature occurred. From this it appears that about 1 per cent. of the cars operated were disabled each day from electrical causes, and about 6 per cent. from mechanical causes. As the report does not state the nature or degree of electrical disablements, it is not fair to assume that they were all due to crippled armatures. All that can be deduced is, that a car may run 100 days without electrical repairs, and only 17 days without mechanical repairs; the cost of this is not stated. In the case of four Sprague cars running on another road, the repairs for six months have cost \$1,191. On these four cars were worn out, 3 bronze pinions, 11 steel pinions, 6 spur wheels, 6 axle brasses, 8 shaft bearings, 12 armature bearings, 180 carbon brushes, 6 trolley wheels, and burnt out 3 field magnets and 6 armatures.

"Public and State Treatment of Corporations," formed the theme of a paper by Mr. G. H. Scribner; this, though interesting, and in some points applicable to our own municipal institution, scarcely comes within the province of an electrical journal. Mr. D. H. Bates read a paper on "The Edco Storage Battery Car," enumerating the conveniences of self-contained cars, and the disadvantages of systems having overhead and underground conductors. There is nothing novel in this paper, and the figures on the cost of traction by means of the Edco system are, of course, hypothetical. The discussion, however, brought forth the interesting fact that various storage battery cars are now being introduced on several new lines, and additional ones put on existing lines.

Mr. Carruthers Wain, of London, was one of the guests at this Convention, and when called upon by the President, gave a description of the accumulator cars which are being tried on the Birmingham central tramways. He stated that during the time the electric cars were in process of construction, the receipts on the horse cars amounted to \$600 a week. Immediately the electric cars were put on, the takings jumped to \$1,250 a week. This was not due to any additional service, because it is precisely the same; not to any increase in population, because it has not grown so rapidly, but simply to the fact that they had been able to put on, in place of the wearisome horse car, a comfortable car moving by electric power. Mr. Carruthers Wain concluded in saying that the question of profit on the workings of the storage battery is not a matter of speculation, but is a matter of dead certainty.

### THE PRESENT COMMERCIAL POSITION OF ELECTRIC LIGHT COMPANIES.

THE present position of the various English electric light companies, from a commercial point of view, is not very satisfactory, and the thought has not infrequently arisen in the minds of some shareholders as to whether they might not have invested their money to greater advantage. It was, however, not to be expected that during the first few years of working the dividend paying stage would be reached, although, in two instances, the statements made in the prospectuses were rather too confident of quick returns—a policy which cannot be too strongly deprecated. Nevertheless, the different metropolitan companies are now settling down steadily to work, and in the course of another year or two, it is possible that the anticipations of the shareholders will be realised, at least, to a certain extent.

It may, however, perhaps be interesting to review the present commercial position of the companies, and to consider their future prospects. Taking the London companies in the order of their share capital, the following table shows the names of the companies, the nominal share capital, the amount paid up, and the approximate number of lamps supplied with current.

Name of company.	Nominal capital.	Amount paid up.	Approximate number of lamps supplied with current.
London Electric Supply Corporation ... ..	£1,250,000	£654,690	40,000
Metropolitan Electric Supply Company ... ..	500,000	201,583	40,000
House-to-House Electric Light Supply Company ... ..	350,000	36,610	10,000
Westminster Electric Supply Corporation ... ..	300,000	18,000	6,000
Kensington and Knightsbridge Electric Light Company ...	250,000	49,780	20,000
Chelsea Electricity Supply Company ... ..	100,500	50,000	20,000
Notting Hill Electric Lighting Company ... ..	100,000	14,734	...
St. James's and Pall Mall Electric Light Company ...	100,000	26,090	21,000

It has not yet been ascertained how much of the gross revenue is absorbed by working expenses, depreciation, &c., but these items are estimated by two companies to amount to about 50 per cent. of the total receipts. This percentage may possibly be considered to be high, being in fact slightly less than the working expenses on an ordinary railway, where they are naturally considerable. The annual income derived from an 8-C.P. lamp installed is variously estimated at from 10s. to 14s., or an average of 12s.; and from an 8-C.P. to a 16-C.P. lamp, £1 per lamp. We will, however, take an

average of these two, namely, 16s. per lamp installed. It will, therefore, not be difficult to estimate the average number of lamps which must be in use throughout the year to enable the companies to pay a dividend of 5 per cent. on the total paid capital, providing, of course, that the working expenses, &c., do not exceed 50 per cent. of the gross receipts. For instance, the London Corporation would have to supply about 80,000 lamps, although, considering the excessive cost of maintaining such a huge station, this number would doubtless have to be increased by probably 50,000 lamps.

The Metropolitan Company, with one-third less of paid-up capital than the London Corporation, would only have to furnish 30,000 lamps, while the House to House Company, with its present number of lamps in use, should afford a fair return at the end of the next financial year. The company, which is expected to yield probably the best return on the invested capital is, however, the St. James and Pall Mall Company which, in a remarkably short period, has obtained customers to the extent of about 21,000 lamps.

It might be supposed from the figures given in the table regarding the paid up capital and the present approximate number of lamps alight, that some of the companies are already in a position to declare a dividend. This assumption is, however, incorrect. The number of lamps stated are those which are at present in use, but these must be the *average for the year* to yield any return; moreover, since the figures concerning the paid up capital were compiled, more calls have been made on the shareholders. Thus the approximate number of lights which would have to be supplied as previously stated would have to be increased by, say, 20 per cent. It may, however, be concluded that the commercial position of the metropolitan electric light companies is gradually improving, that in the course of a year or two the dividend-paying stage will be attained, and that the shareholders may rest assured that their investments are assuming a form of stability.

A. W.

### THE PRENTICE MAGNETIC CUT-OUT.

THE accompanying illustrations represent a new magnetic cut-out, which is being placed on the market by Mr. Napier Prentice, of Stowmarket, Suffolk. The cut-out comprises an electro magnet wound with wire, in-

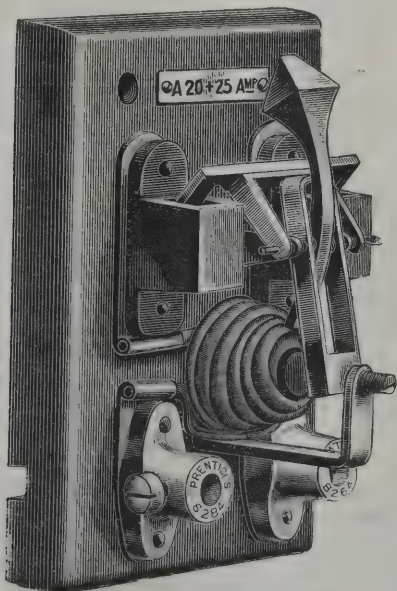


FIG. 1.

cluded in or taken as a shunt from the circuit to be controlled, the external wires being secured by the binding screws shown. These screws are arranged on conducting pieces, one being electrically connected

with the conducting piece carrying the mercury cup on the right, and the other being similarly connected through the coil of the magnet with the conducting piece carrying the second mercury cup. Into these cups dip the ends of the horizontal bridge piece, which is provided with arms carrying the armature. These arms are connected by a cross piece extending behind the vertical lever, which has a counterbalance weight at its upper end, and a tail piece constituting a kicker. The screw shown in front of the armature permits of the position of the latter relatively to the end of the

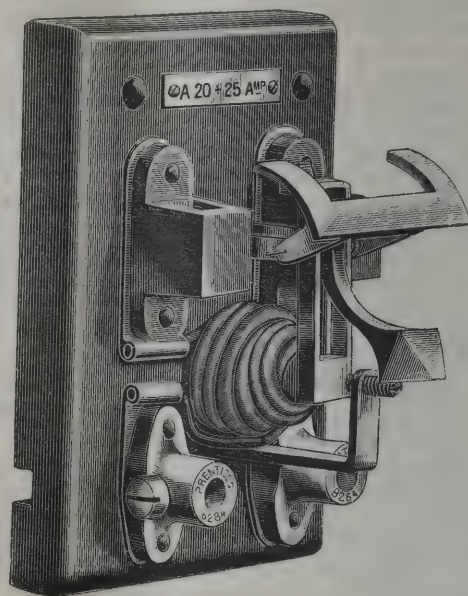


FIG. 2.

magnet core being adjusted. The parts are mounted upon a base of enamelled slate. When the normal current is passing, the armature, bridge, arms, and lever remain as shown in fig. 1; but on the current increasing abnormally, the electro-magnet attracts the armature and the cross piece moves the vertical lever so that its weighted head causes it to fall over in such a manner that its tail end kicks the bridge and knocks it over into the position shown in fig. 2, thus removing the contacts out of the mercury cups, and breaking the circuit.

### GOOLDEN AND CO.'S STEAM DYNAMO.

WE illustrate in our present number a steam dynamo constructed by Messrs. W. T. Goolden & Co., which differs in some essential features from the common arrangements of dynamos, coupled as in this case to Willans engines.

The steam dynamo illustrated is one of a series constructed for the St. John's Wharf Central Station of the Westminster Electric Supply Corporation. It will be noted that the oertype pattern dynamo has been adopted, this being, in the opinion of the makers, a superior arrangement in all cases of dynamos not exceeding 50 kilowatts output, the armature being readily removable without taking away any part of the field magnets, and the brushes, both upper and lower, being readily accessible.

The dynamo itself has the field magnets of wrought iron, bored out to receive the armature; these are bolted to the bedplate, which forms the back yoke of the magnets. The bore of the fields is so arranged as to allow a greater clearance at the lower part than at the upper, thus doing away with a slight downward pull due to unequal distribution of magnetism in the upper and lower half of the armature.

The outside end bearing of the dynamo is mounted in a spherical seating, to allow it to adjust itself in the event of uneven wearing of the different bearings, and prevent any strain being thrown on the shaft.

The armature is a special pattern of bar armature, which has been adopted by Messrs. W. T. Goolden and Co., the bars themselves being laminated, and connected at the ends by a "solid built" armature end composed of V-shaped radial strips, built and insulated with mica, after the manner of a commutator, in combination with spiral strips, also separated and insulated with mica.

The armature end built in this manner, which presents the appearance of a solid disc, is mechanically very strong, and prevents the ingress of dirt or wet, which often affects the insulation at the ends.

The field magnets are internally, as well as externally, ventilated.

The brushes are of Messrs. Goolden's patent type, having screw feeds, enabling them to be fed forward whilst running, without unslacking any nut or screw.

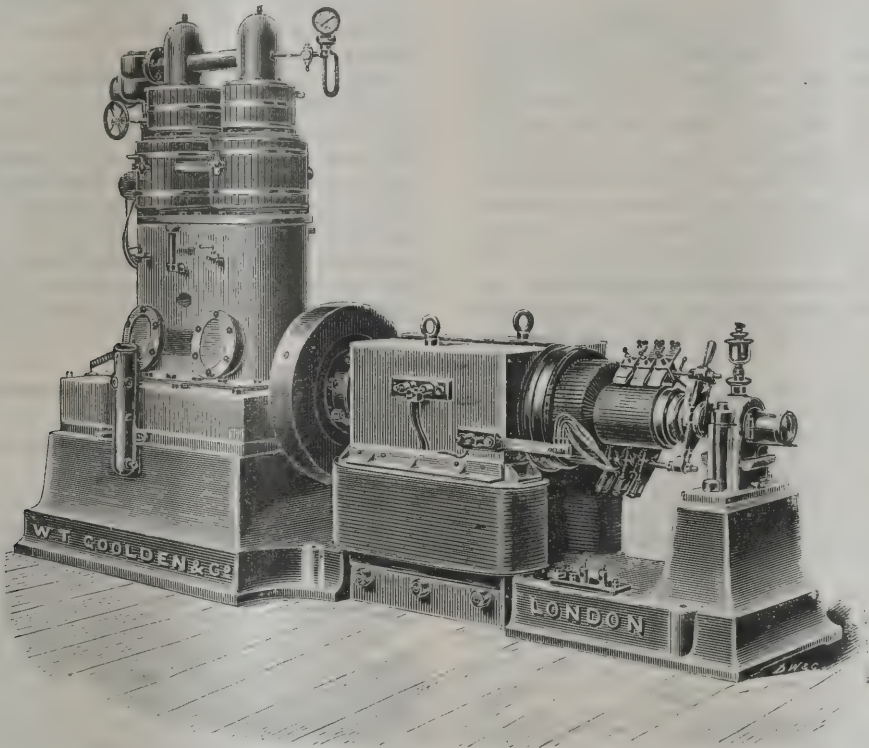
2. The armature shaft and core were put in place, no windings being on, and running with the fields unexcited 9.92 I.H.P. was recorded, equivalent to 1.49 I.H.P. for the shaft.

(It is to be noted that this is excessive, as the bearing at the time was running hot.)

3. The core being in, the fields were excited, and 11.56 I.H.P. recorded, the loss in the core being thus 1.64 I.H.P.\*

4. The armature was wound, and another test made, first unexcited then excited, and deducting the value for the losses in engine, shaft and the core previously ascertained, the loss in Foucault currents in the bars was found to be .34 I.H.P.

The experience and experiments of Messrs. Willans show that the frictional loss in the engine is nearly independent of the load. Hence, from the above figures,



COMMERCIAL EFFICIENCIES OF DYNAMO AND STEAM DYNAMO.

I.H.P. reduced to watts.									Output in watts.			Efficiency.	
Proportion of full load.	Loss in shaft.	Loss in core.	Loss in bars, eddy currents.	Loss in armature resistance.	Loss in field magnet coils.	Total loss in dynamo.	Loss in engine.	Total loss in dynamo and engine.	Volts.	Ampères.	Watts.	Commercial efficiency of dynamo.	Commercial efficiency of combined engine and dynamo.
1	290	1,220	254	1,820	660	4,244	6,300	105,44	120	375	45,000	91.2 p.c.	81 p.c.
$\frac{1}{2}$	290	1,220	254	520	660	2,944	6,300	92,44	120	200	24,000	89.1 p.c.	72.2 p.c.
$\frac{1}{4}$	290	1,220	254	130	660	2,554	6,300	8,854	120	100	12,000	82.5 p.c.	57.5 p.c.

The following tests which have been made of these machines are interesting, as showing the proportion which exists between the various losses occurring in a steam dynamo of this class, and which is to be noted, that although the efficiencies given are exceedingly good results, the engines and dynamos were perfectly new at the time of the tests, which were made for the makers own information, and not originally with a view to publication.

The electrical data are as follows :—

Volts, 120 ; ampères, 375 ; watts, 45,000 ; speed, 440 ; armature resistance, .013 ohms ; resistance of field magnet coils, 21.4 ohms.

Indicator tests of Goolden-Willans combination :—

1. The engine was run, with the armature disconnected, and found to absorb 8.43 I.H.P. when running light at 430 revolutions.

the efficiency of the steam dynamo can be given for any load, and the commercial efficiency of the dynamo calculated for any output.

The table below shows the calculations tabulated, it being noted that the loss in the shaft friction has been taken at .39 I.H.P. (this value was found to represent an average in later tests, the above value being exceptional, owing to the circumstances mentioned, but the individual test being for a difference, this was unimportant).

These calculations accord well with direct indicator

\* The loss in the core is probably considerably augmented by the fact that this dynamo was originally intended for 105 volts, but the field excitation was raised to give 125 volts at the original speed, the induction being thus increased, the leakage through the shaft and spider has been increased, thus causing eddy currents and loss.

tests. The dynamo giving 43,400 watts, the efficiency as indicated was 80·4 per cent., and, when giving 26,500 watts, the efficiency was 72 per cent.

Independent tests of these dynamos and engines at the stations, supplying current to the Houses of Parliament, have been since made by Prof. A. Kennedy, consulting engineer to the Westminster Electric Corporation, giving even better results than the above. The commercial efficiency in some reached as high as 85 per cent. and 86 per cent. ; but as further tests are being carried out on the same machines, the results are not yet complete.

THE NOMINAL LUMINOUS POWER OF CONTINUOUS CURRENT ARC LAMPS.

WE have long protested, writes the editor of *L'Electricien*, against the use of unsuitable or inaccurate terms, and vague designations which are only kept in use by custom and prejudice. By dint of repeating our assertions we may perhaps succeed in getting the matter taken up by others who are not the slaves of custom ; we shall therefore not fail to call attention to abuses of this kind whenever an occasion presents itself. We will, therefore, now discuss the (in our opinion) deplorable custom of characterising arc lamps by their more or less nominal photometric power.

In order to show how meaningless such designations are, we have drawn up a table from the books, catalogues and prospectuses of the chief industrial celebrities of both worlds, placing opposite each intensity of current feeding a given arc lamp, its corresponding nominal photometric power. In order to facilitate comparison we have reduced all the intensities expressed in carcel burners to decimal candles, considering the carcel burner to be equivalent to 10 decimal candles, although really, according to M. Violle, 20 decimal candles = 2·08 carcel burners ; there is, consequently, a difference of 4 per cent. between the decimal candle and the tenth of a carcel burner, but our estimate will be sufficiently accurate for our purpose.

Table of Nominal Intensities of Arc Lamps according to the constructors.

Intensity of current Amperes.	Sautter-Lemonnier	H. Fontaine.	Cance (under a globe).	Schuckert.	Crompton.	Latimer-Clark.	Ball.	John Davis.	Antwerp experts (1889).	M. Tischendorfer's Formula.
	B.D.	B.D.	B.D.	N.K.	C.	C.	C.	C.	B.D.	N.K.
4	200	...	250	300	...	...	800	...	526	300
5	350	500	300	...	500	400	...	400	...	...
6	500	...	350	600	...	...	1,200	...	487	625
7	...	...	400	...	...	...	...	...	...	...
8	...	1,000	450	1,000	1,000	...	1,600	...	600	1,000
9	...	...	Breguet	...	...	...	...	...	...	...
10	...	...	700	1,400	1,400	1,500	2,000	1,000	700	1,425
11	...	...	...	...	...	...	...	...	...	...
12	...	...	...	2,000	...	...	...	1,500	...	1,900
13	1,500	...	...	...	...	...	...	...	1,190	...
14	...	...	...	...	...	...	...	...	...	2,425
15	...	2,000	...	...	...	3,000	...	2,000	1,380	...
16	...	...	...	3,000	3,000	...	...	...	1,660	3,000
18	...	...	...	...	...	...	...	...	...	3,625
20	...	...	1,500	4,000	4,000	...	...	3,000	1,980	4,300
22	...	...	...	...	...	...	...	...	...	...
24	5,000	...	...	...	...	...	...	...	...	5,800
25	...	3,500	...	...	...	...	...	...	...	...
30	...	...	...	...	...	...	...	...	...	8,425
40	...	...	...	...	...	...	...	...	...	13,800
50	20,000	...	...	...	...	...	...	...	...	20,425
60	...	10,000	...	...	...	...	...	...	...	...

(B.D.—(decimal candle). N.K.—German normal candle.  
C.—English candle.)

The figures in this table show that a constructor, describing his machine as producing so many arc

lamps of so many candles each, gives it a designation which may perhaps facilitate its sale, but which is practically meaningless, since, with a given current, the quality of the carbons, the distance between them, their diameter, &c., may cause the luminous intensity to vary considerably, its value being in some cases even more than doubled. And we must not lose sight of the fact that in arc lamps mounted in derivation, the available potential at the terminals of the lamp being from 43 to 45 volts, some installations work at 80 effective volts, others at 75, 70 or 65, the difference being absorbed at an utter loss in a rheostat.

The same objections may be raised to the mode of designating dynamos and transformers by the number of incandescence lamps that they can feed. Some constructors mean lamps of 30 watts, others lamps of 40, 50, 56 or 60 watts.

A dynamo or transformer should never be designated in any other way than according to the number of available watts it can produce at a maximum normal charge.

Lastly, as regards accumulators, the statement of the weight of the plates conveys no meaning to us. We should like to see accumulators designated according to their maximum normal output, in ampères or in watts, and according to their effective capabilities in ampère-hours or watt-hours, for these are the principal essentials, which together with their price and duration, enable us to calculate quickly the number and the coupling of accumulators required for a given installation, much more accurately than the weight of the plates.

THE ELECTRIC LIGHTING OF DRESDEN.

[FROM A CORRESPONDENT.]

WHAT is thought in municipal circles in Dresden on the present position of electric lighting is curiously illustrated by a report in the *Teplitz Zeitung*.

On October 16th, this year, there was held a session of the Town Councillors of Dresden, the first item in the order of the day being to receive the report of the Chief Mayor, Dr. Stübel, on the preliminaries for the municipal electric works as proposed for Dresden. It is known that after various explanations and negotiations with Siemens and Halske, of Berlin, and the German Edison Company of the same city, who had both submitted calculated projects, it was resolved by the Dresden Town Council, on May 1st, 1887, that electric works should be erected at the cost of the city, to which resolution the municipal delegates gave in their adhesion on May 26th of the same year.

A mixed committee for this affair was then formed, and projects were submitted by Siemens and Halske, Kummer and Co., and Schuckert and Co. The German Edison Company had withdrawn its proposals. In the report of the Mayor-in-Chief, Dr. Stübel laid before the above municipal session the erection of a municipal electric works for a maximum connection of 25,000 glow lamps, and an outlay of 2½ million marks was recommended. The number of the gas flames installed in Dresden consists of 6,300 street lamps and 175,000 private lights. Consequently the proportion between electric light and gas expected by the Dresden authorities was 1 : 7.

At the meeting of representatives on October 16th, 1890, Dr. Blochwitz acted as reporter of the committee, which proposed that, "The committee decline the proposals of the Town Council, and hesitate at present to undertake the erection of municipal electric work, and prefer to await the results of the electric exhibition, to be held at Frankfort-on-the-Maine in 1891, and at the same time express the wish that in future, as in all extensive municipal undertakings, a competition should be invited, and that after the presentation of the projects a committee, consisting of at least three experts, should be formed for their examination."

In support of this motion, the reporter submitted that haste should be avoided; the affair was too serious, and millions of money might be sunk too rapidly. The charge was brought against Dresden that it came halting in the rear of all improvements; this was not here the case; there were not, so far, many electric stations, and a variety of experience will be obtained. The application of the accumulators recommended by Siemens is for the present merely an experiment. There are many more important things which should be done first—*e.g.*, the market halls, the exhibition hall, &c. He strongly urged that the proposal of the committee should be accepted. The town councillor Hartsig followed on the same side. He had, he said, informed himself practically on the electric lighting in Berlin. The frequent repairs which were there required in the cable from the Central, and other experiences, induced him to agree fully with the recommendation of the committee. He was of opinion that more experts should have been consulted. Above all, he regarded it as necessary to mention something which had not yet been openly brought forward, *i.e.*, the general public was of opinion that the electric lighting of the streets was involved in the erection of electric central works. This is an error, as nothing of the sort is, for the present, in contemplation. The public has therefore at present no immediate interest in the question. The loss and the interest on the say, three million marks required for the new works, must ultimately fall upon the community of the tax-payers. The entire installation was merely for people of distinction; for the little man (*anglice* for the poor man) there was here nothing. Lighting with the aid of accumulators was so young a child, that it might well be allowed to grow for a couple of years. There was no pressure; the electric lighting of business houses, offices, saloons, &c., is not absolutely necessary, like street cleansing, water supply, &c.

In Berlin he had heard nothing but lamentations from men of business compelled, by competition, to adopt the electric light, and troubled by the high price and the frequent repairs. He found the restaurants and cafés lighted electrically generally very dim, so that it was often scarcely possible to read the papers.

After some concluding remarks from Blochwitz, the reporter who said that the introduction of the electric light would not diminish the income of the gas company, the opinion of the committee was accepted by 47 votes against 17.

### THE BULL RING OF THE RUE PERGOLESE.

THIS enormous building, devoted to somewhat feeble imitations of Spanish bull fights, has been recently covered in, and in order to make use of the edifice at night, either for bull fighting or for concerts, lighting by electricity has been introduced.

The arena is circular, and has a diameter of 197 feet; the dome which covers this springs from iron columns 98 feet in height, surrounding the arena. From the ground to the centre of the dome is 190 feet. The exterior of the building is in shape a 30-sided polygon, described on a circle whose diameter is 328 feet. There is seating accommodation for 22,000 persons. Light ironwork supports the glass of the dome, the central portion of which can be bodily raised between 12 and 13 feet, so as to ventilate the building in summer. The movable portion of the dome has a diameter of 98 feet. At night, the principal source of light comes from just below the movable roof, that is to say, at a height of 197 feet. Here is a sunlight of the Patin type, and, in addition to this, a circle of 150 arc lights are arranged round the dome, the total lighting power being thus brought up to 30,000 candles. The two galleries are each provided with 60 Cance incandescence lamps of 32 candles, and the ground floor passages are lighted by 16 Cance in-

candescence lamps of 100 candles each, and 16 arc lamps, Patin type, of 8 ampères. The offices and dressing rooms are supplied with 200 incandescence lamps of 16 candles.

Especial attention has been paid to the arrangement, fitting, and construction of the engine, boiler, and dynamo rooms, with the result that they are in reality works of art, and will no doubt produce the effect of not only familiarising numbers with electric lighting, but also of increasing public confidence in this method of illumination, and of extending its application.

There are three Collet boilers, each supplying 3,300 lbs. of steam per hour. One of these boilers is kept in reserve, while the other two feed a Powell engine of 300 H.P., and a compound Chaligny engine of 100 H.P.

The alternating current is produced by a Ferranti dynamo of 3,000 lamps, and 4 Gramme machines of 200 lamps at 8 ampères.

There is also a battery of accumulators for feeding the relief lamps in case of accident to the main lighting.

### REVIEWS.

*The Year Book of Commerce.* Compiled under the authority of the London Chamber of Commerce, and edited by KENRIC B. MURRAY. London: Cassell and Co.

This is the second of the series of yearly volumes, prepared specially for business men, by the London Chamber of Commerce, with the object of showing the movement of the foreign trade and general economic position of the leading countries of the world. The volume, as compared with the former issue, gives additional statistics on a variety of topics of considerable value. In tables, now printed for the first time, information is given as to British trade with European countries under commercial treaties, with the increase of their population, and trade movements in 1888 as compared with 1860, international telegraph statistics, the progress of British trade since 1855, with quinquennial averages, rates of wages, trade of some of the South American States, China and Japan, and several others. With reference to the first-named table, the editor remarks that it affords most appropriate food for thought at the present moment. "This gives at a glance population and trade statistics of 17 European countries or states, in addition to the United Kingdom, with a record of the date of coming into force of the respective commercial treaties of Great Britain with them. Upon the total statistics the increases per cent. of population, of total imports and exports, of imports into the United Kingdom from, and exports from the United Kingdom to, the various countries are, as far as obtainable, stated in each instance. The illustration thus afforded is one which every business man can appreciate, and which points its own moral. At this juncture it has exceptional importance. The Continent of Europe seems destined, in 1892, to be involved in a rearrangement of its Customs tariffs of a wholesale nature. What France is inclined to do in that year, when all her principal commercial treaties expire, has been made very evident, and there, at any rate, there is little hope of a relaxation of the State-imposed barriers to commercial intercourse. Following in the train of the French treaties, most of the European States will be obliged to reconsider their position. It is therefore worthy of being noted that as far as British commerce with Russia, Sweden, Norway, Denmark, Holland, Belgium, Germany, Switzerland, and Austria-Hungary is concerned, it is regulated by treaties terminable upon a year's notice, which may thus be given early next year to expire in 1892. The British commercial treaty with Roumania terminates in July next; the treaties with France and Italy on February 1st, 1892; and those

with Spain, Portugal, Montenegro and Bulgaria at various dates in 1892. Consequently the position is one which cannot be ignored, and that it is realised by Her Majesty's Government is shown by the appointment of a Special Consultative Committee, in connection with the Board of Trade, to 'consider the approaching expiration of various commercial treaties, the probable effects upon British trade of such expirations, and the arrangements which may or should be made in lieu of those treaties.'"

*Magnetism and Electricity: A Class Book for the Elementary Stage of the Science and Art Department.* By J. SPENCER, B.Sc., Head Master, Science Department, Bradford Technical College. London: Percival & Co., King Street, Covent Garden.

The method adopted in this book of arranging the whole of the matter in a series of experiments has much to recommend it, as it appeals very forcibly to the student, but beyond this point there is but little to call for notice in the work, as it has no marked superiority over other excellent treatises which exist. The general arrangement of the matter is satisfactory, the illustration clear and fairly good, though, as is usual with teachers who have had no, or little, practical experience, descriptions of practical applications are exceedingly absurd; witness the description and illustration of an electric telegraph on page 135. Although we cannot highly praise the book for being written "to supply a want," we can at least say that those who purchase the same for the purpose of learning about electricity and magnetism will, if they carefully go through the whole course of experiments, obtain very thorough instruction in the elements of the subjects.

#### *Sound, Light and Heat.*

This book, by the same author and publisher as the foregoing, is a companion to the above, and does not call for any special remark. It is undoubtedly a handy volume.

*Practical Inorganic Chemistry. Elementary Stage.* By E. J. COX, F.C.S., Head Master of the Technical Science School, Birmingham. London: Percival & Co., King Street, Covent Garden.

This class-book is intended for the use of students preparing for the examinations of the Science and Art Department in the elementary stage of Practical Inorganic Chemistry. The whole arrangement of the book is exceedingly simple and thoroughly practical. The diagrams, which conclude the work, are very clearly drawn.

*Elementary Manual of Magnetism and Electricity. Specially arranged for the use of First-Year Science and Art and other Electrical Students.* By ANDREW JAMIESON. London: Charles Griffin and Co., Exeter Street, Strand.

This volume is a republication of the three manuals on "Magnetism," "Voltaic Electricity," and "Electrostatics," which we have noticed in a previous review; to the latter we have nothing to add, except to say that the complete volume forms an excellent elementary treatise on the subjects of electricity and magnetism, very practical in its arrangement, and possessing sufficient points of novelty to justify its publication.

#### THE WALKER AMMETER AND VOLTMETER.

ALTHOUGH there is at present a very large number of measuring instruments for electric light stations upon the market, embodying in their construction a great variety of principles, the one which is herewith described is somewhat different from most heretofore brought into use. There can be no doubt, says the *New York Electrical World*, that there is great need of a cheap and accurate instrument which is

easily calibrated, and the scale divisions of which are of equal length. An instrument which would seem to fulfil these conditions is illustrated upon this page. It is the invention of Mr. G. W. Walker, of this city, and in its construction he has made use of the principle which he has already utilised in his recording meter, described and illustrated some months ago in our columns. In its design Mr. Walker has endeavoured to provide a meter containing the fewest possible number of parts, and these of the simplest character consistent with accuracy and durability, and at the same time to reduce the cost of construction to so low a figure that the instrument could be placed upon many circuits which are now unprovided with meters, because of the large expense necessary in securing a satisfactory one.

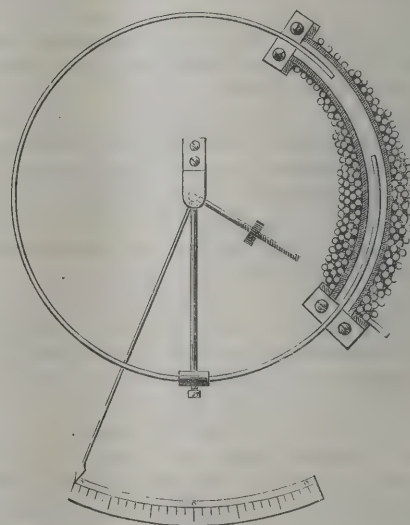


FIG. 1.

Fig. 1 shows very clearly the construction of the meter and all of its parts. A solenoid magnet of arc shape is secured in position against a suitable support by means of screws. A circular core of iron, somewhat hardened, and extending over about 270 degrees

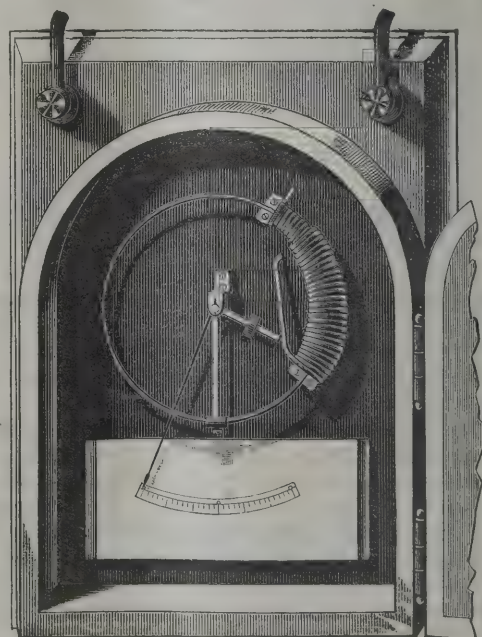


FIG. 2.

of circumference, is carried upon a bar, which is pivoted at the centre of the instrument, and swings in jewelled bearings. The needle or pointer of the instrument is also carried upon this same axis, and extends outward beyond the core to the reading scale, as shown in the figure. An arm which is threaded to receive a nut-like weight, as shown in the figure, is carried from the same centre, and by means of this the core may be balanced, so that when the instrument is not in circuit,

the pointer will stand at the zero of the scale. The solenoid is composed of a curved non-magnetic tube, and a helix of insulated wire wound upon the tube, which serves only as a support, so that it tapers or decreases in diameter from one end to the other, either gradually or by steps.

The core is made of comparatively hard iron, its free ends being joined by some non-magnetic material, such as brass, for the purpose of support, so that the core may be kept in a perfectly circular form. The ends of the core are arranged so as to stand within the coil when in a normal position. The upward end, however, may be made to stand without the coil, but within the field of repulsion of the magnet, the other end standing when in a normal position at a point about midway the length of a coil. By using a core of small diameter, it may be saturated by a slight percentage of the current used in the meter. The fact that the pointer moves over equal divisions on the scale for equal increments of current passed through the instrument, is attributed by Mr. Walker to the fact that the core, instead of being of soft iron, is somewhat hardened, and also to the fact that the coil which exerts the attractive and repellant influence upon the core is wound in the tapering manner described above.

Fig. 2 shows the instrument completed. The same construction, with the exception of the substitution of a fine wire of high resistance for the solenoid, makes the instrument a voltmeter instead of an ammeter, and both of these instruments are now made by the Walker Electric Company.

## POLARISING CONDITIONS IN A GALVANIC BATTERY.\*

By PROF. A. E. DOLBEAR.

WHEN hydrogen accumulates upon one of the plates of a galvanic battery so as to reduce the current, the cell is said to be polarised, and various methods have been devised to prevent this, some chemical, as in two fluid cells, and some physical, as when the plate is rotated, and these are called depolarisers; the idea being that the polarisation itself consists simply in the accumulation of gas upon the plate. I do not know that any attempt has been made to explain the underlying conditions present where chemical action is present or latent in a battery, which bring about such a result, for it is plain that such a result must have some antecedent physical conditions that determine it.

The following explanation has seemed to me to be probable, and the commendations of a number of my electrical friends induce me to publish it, not as proved, but as a step towards a clearer understanding of the mechanical conditions present in a galvanic battery.

When a piece of zinc is immersed in water it is found to be electrified, and its potential may be measured by a suitable electrometer.

Now, we know from purely chemical sources that there is chemism, or chemical attraction, existing between zinc and oxygen, and that under favourable conditions zinc will be oxidised. This so-called affinity of zinc and oxygen is not suddenly created by their juxtaposition under certain circumstances, but exists all the time, only waiting for an opportunity to show itself.

What then are the real conditions present when a piece of zinc is immersed in water? The zinc is a solid, the molecules cohere, and there is a certain degree of rigidity to the molecules. With the water it is different. As a fluid, the molecules are free to move about among each other with but little internal friction. As the molecule of water is made up of both oxygen and hydrogen, it may have an oxygen side and a hydrogen side, in which case, if there be any selective agency acting more upon the oxygen part of the molecule than upon its hydrogen part, and if the molecule as a whole

is capable of shifting its position easily by a simple rotation upon any axis, as is true in this case, then all the molecules of the water that come in contact with the zinc must be oriented by the zinc so that the oxygen side of the molecule faces the zinc at every point, and consequently the hydrogen side is away from it. This would be a true polarisation of the molecules of water, and the distance to which it would extend would depend upon the strength of the chemism between the two acting elements. Such a chemical field might extend indefinitely.

When a piece of carbon or copper or other element is placed in water, it exhibits similar electrical property, but different in degree from that of zinc; so similar polarisation of molecules would be set up about it. The difference in the degree of chemism between the two elements and the oxygen of the water would determine the rate of oxidation under given conditions, and this difference we call the electromotive force of the cell. Also, the mere fact that there was a difference in this particular between the two immersed elements would tend to produce between them a similar condition of arranged or polarised molecules.

All this might be expected to occur, whether there was a chemical reaction or not, that is to say, whether or not the zinc was dissolved and water decomposed. Whether this happens, or not, depends upon the degree of tension represented by the difference in the so-called chemism between the two elements, which difference we measure in volts, and needs to be about 1.5 for water.

If other solutions than water be used, the same mechanical conditions and arrangements would be present, differing from it only in degree.

The substance of the idea is this, that the chemism existing between the zinc and the element oxygen in the water *compels* the molecules of the water to turn so as to present their oxygen side to the zinc, which they are able to do freely, because such movements are not subject to appreciable friction in the liquid.

When the other battery element cannot combine with oxygen in any degree under the existing conditions, as when carbon or platinum is used, then only hydrogen will be set free, as there is a greater stress for the oxygen at the other element, and there must be an exchange of partners among the molecules along the whole line between the elements, according to Grothius's hypothesis; so that, underlying the accumulation of hydrogen called polarisation, is a real polarisation in which all the molecules are facing one way from the mechanical necessities present.

It seems not unlikely that this condition of things in a heating liquid might be observed by noting the effect produced by it upon a beam of light transmitted through the liquid, especially upon reversal of electrical condition.

## THE PROPOSED PACIFIC CABLE.

THE project of connecting Australia with Canada by a cable across the Pacific Ocean has now been before the public about 10 years, having been first suggested by Mr. Sandford Fleming in a report submitted to the Dominion Parliament in 1880. As a practical question, however, the history of the proposal may be said to date from 1887, when a conference of delegates from various parts of the British Empire was held in London. At this meeting the plan was fully explained by the delegates from Canada—Mr. Sandford Fleming and Sir Alexander Campbell—and aroused a great and for the most part a friendly interest. At the same meeting there was also revealed the fact that the project had a strong opponent in the Eastern and Eastern Extension companies, which now control the telegraphic communication between Australia and Great Britain, and enjoy a monopoly which would be destroyed if telegrams could be sent across the Atlantic, then through Canada, and then across the Pacific Ocean to Australasia. The conference adopted a resolution declaring "that the connection of Canada with Australasia by a direct submarine telegraph across the Pacific is a project of high importance to the empire, and every doubt as to its practicability should without delay be set at rest by a thorough and exhaustive survey." The favour with which the idea was received appears to have alarmed the existing companies, for last summer they endeavoured to make an

\* The Electrical Engineer.

arrangement which would have given their monopoly a new lease of life. They offered to reduce their cable rates one-half on condition that the Governments interested would give a guarantee equivalent to about £54,000 a year. The Australian colonies were willing to enter into this arrangement, but Great Britain and New Zealand declined to share in the guarantee, and there the matter stands to-day. In the meantime Mr. Sandford Fleming took the opportunity to explain the Pacific plan, and it will be convenient at this point to state the nature of the arguments which he used. It was contended by Mr. Fleming that the guarantee asked for in consideration of the reduction of the rates of the old company, namely, £54,000 a year, would be equal to the annual charge upon the capital required for the construction of a cable from Canada to Australia. The length of the cable necessary to stretch across the Pacific from Canada to New Zealand and Australia is estimated by competent authorities at 8,900 miles, and Mr. Fleming says that the outside cost of a cable of the very best type would be £1,800,000. Three per cent. upon this sum would amount to £54,000 a year. It is further pointed out that the building of the Canadian line would reduce the cost of messages from England to Australia to one-fourth what they are now, while the proposal of the existing companies is to reduce them by only one-half. The length of the line is not so formidable an obstacle to the success of the project as may at first sight appear; for owing to the presence of a number of stations in the Pacific, the longest stretch would be about 2,700 miles, the others ranging from 1,200 miles upwards.

So far as we can judge, the Australian colonies and Great Britain would stand to gain by the construction of a line which would destroy the monopoly of the old companies, effect a great reduction in rates, and give them a telegraph route lying entirely in the Atlantic and Pacific Oceans and in Canada, and therefore much less liable to be interrupted by an enemy than a route following the old lines of commerce. Canadians, of course, would take a friendly interest in a project which would benefit our sister colonies and Great Britain, and the question of Canada assuming any, and if so what, share of the expense of the scheme may safely be left for future consideration. It will be seen at once that her direct interest in the matter is not so great as that of Australia and England, the volume of business between those two countries being vastly greater than the volume of business between Canada and Australia. It is to be presumed that the promoters of the plan recognise this fact and would expect Canada to bear a corresponding small share of the expense. It is quite possible that in the future new conditions may arise which will greatly enhance the importance of the project from a Canadian standpoint. Her commerce upon the Pacific, now in its infancy, may grow to large proportions, especially if the statesmen of the future age are wise enough to adopt a policy which will promote instead of hindering the growth of commerce. In such a case the construction of a cable across the Pacific would be a matter not merely of importance but of necessity. From the imperial standpoint the importance of having a line from England to her Eastern possessions, laid wholly in the open seas and in countries under the British flag, would undoubtedly be of great importance; and to this aspect of the case British statesmen will no doubt give due consideration. —Globe, Toronto.

ELECTRICAL TRADES SECTION.

A MEETING of the section was held at Botolph House on Monday last, Mr. R. E. Crompton in the chair.

THE BOARD OF TRADE RULES.

The Chairman said, in reference to this matter, it had been left to him to prepare a formal document and submit it to the Council of the Electrical Engineers. He had been unable to carry out these instructions as no meeting of this body had taken place; however, he met the chairman and the secretary, but the result was not satisfactory, in so much as the president said he preferred that the initiatory action should be taken by the Electrical Section, who might submit to the engineers and the Board of Trade a formal letter stating that the rules were anomalous and a hindrance to the industry. Considerable energy had been spent by Mr. Wharton, Mr. Sellon, Mr. Gray and himself in having the conditions altered; they had privately sent to the Board of Trade two memorials, and he considered if one on the top of these came from the section it would probably move them in the matter. The situation was extremely critical; his firm, Messrs. Wharton and the Brush Company, had at the present moment installations running, the overhead wires of which were not in accordance with the Board of Trade rules, and it was impossible to make them so. They took objection to two rules, one of which said that every wire, whatever its thickness, should have a rubber or material to the thickness of one-tenth of an inch outside the copper, outside that there should be the usual protection of braiding. The Silvertown people informed him that if this rule were enforced, a wire to carry the smallest high pressure current for town lighting or transmitting power, would cost £70 to £80 per mile. The wire which was guaranteed by the Silvertown engineers cost £28 per mile, such a monetary burden therefore, would in most cases prohibit electric lighting. Another objectionable rule was that which laid down that it was absolutely necessary in all cases to use suspenders. This, again, would further increase the cost, and under those circumstances there could be little extension

of electric lighting. He spoke as one who knew, as he had 39 miles of conductors in Chelmsford which were put up before these rules were made. It seemed as if Major Cardew wanted safety at any price, no matter whether it prohibits electricity or not. In reply to Major Flood Page as to whether there was additional safety in these rules, he said it was quite the contrary, for when a wire was covered with a thick coating, it was difficult to centralise, there was more liability of the insulation being cut, and it was more liable to tear. The Silvertown company had paid special attention to this subject and it was claimed that their wire was perfectly safe; even Major Cardew admitted this, but when he got back to the Board of Trade office he made rules which are quite different. He considered the whole system of the Board of Trade unsatisfactory. The committee of the Electrical Engineers, who were responsible for the rules, were not practical men, and he held that they could not therefore draw up suitable rules.

After further discussion it was decided that Mr. Crompton should wait upon the Council of the Chamber of Commerce to see if pressure could be brought to bear on the officials of the Board of Trade, in the event of this not having effect, questions will be asked in the House of Commons.

THE QUESTION OF CORRESPONDENT.

Mr. Garcke said he and Major Flood Page undertook to bring forward a scheme dealing with this question. After referring to the loss sustained through the resignation of Mr. Trotter, it had struck them some new arrangement might be made, and it was that the chairman and the two vice-chairman should constitute themselves a kind of working committee, and if the Chamber of Commerce provided them with a junior clerk, pressing matters would receive efficient attention. It would practically resolve itself into an executive committee who would meet at intervals and report to the committee of the section the work done between the meetings.

INTERCHANGE OF INFORMATION.

Mr. Crompton had prepared a circular letter and tables which it was proposed to send to those who became members, for the purpose of supplying information as to cost of maintenance of stations and working expenses. This scheme was referred to by us in a recent number.

It was decided that copies of the tables should be sent to all members of the section for suggestions.

After Mr. Murray had referred to the expiration of many of the tariffs in 1892, the meeting terminated.

ELECTRIC LIGHTING IN PARIS.

WE take the following statistics as to the progress of electric lighting in Paris between the years 1885 and 1889, from the *Lumière Electrique*; the figures given refer to electric lighting by the municipality:—

Year.	Number of lights.	Systems.	Employed.	Number of fires caused by electricity.
1885	68	14 Lontin ... 12 Jablochhoff ... 40 Brush ... 2 Siemens ...	Place du Carrousel ... Parc Monceau. Parc des Buttes-Chaumont. Champ-de-Mars.	1
1886	66	14 Lontin ... 12 Jablochhoff ... 40 Brush ...	Place du Carrousel ... Parc Monceau. Parc des Buttes-Chaumont.	4
1887	63	14 Lontin ... 12 Jablochhoff ... 37 Brush ...	Place du Carrousel ... Parc Monceau. Parc des Buttes-Chaumont.	2
1888	65	14 Lontin ... 12 Jablochhoff ... 39 Brush ...	Place du Carrousel ... Parc Monceau. Parc des Buttes-Chaumont.	3
1889	393	14 Edison ... 40 Popp ... 37 Edison ... 27 Marcel Deprez	Place du Carrousel ... Boulevards, Concorde to Opera. Place de l'Opera to the Porte Saint-Denis. Porte Saint-Denis to the Place de la République.	33
		6 P ... 12 Jablochhoff ... 47 Brush ... 186 Various ... 24 " ... 35 Edison ... 16 P ... 4000 P ... 1300 ... 509 ... 287 ...	Place Clichy. Parc Monceau. Parc des Buttes-Chaumont. Halles Centrales. Halles Centrales. Galleries of the Palais-Royal and the Theatre Français. Parc des Buttes-Chaumont. Reception rooms of the Hotel de Ville. Council, board rooms, and offices of the Hotel de Ville. Basements of the Halles Centrales. Private service.	

NOTES.

**Lighting of the Ménagère.**—An important electric light installation has just been completed in Paris at the well-known warehouses and shops of La Ménagère. The current is supplied from the station of the Parisian Power and Electric Lighting Company, situated in the Rue des Filles-Dieu, and the installation has been put up by the Electric Lighting and Apparatus Company. It comprises 110 Cance arc lamps of 8 ampères, arranged two in series, and 161 incandescent lamps of 16 candle-power. Of the arc lamps, 20 are installed in the basement, 47 on the ground floor, 22 on the first floor, 15 on the second floor, and the remaining 6 in the annexe, balcony, and a side street. The incandescent lamps are similarly distributed throughout the buildings. Each series of two arc lamps is fed from a separate circuit, having an E.M.F. of 110 volts at the switch-board, whilst the glow lamps receive current from four main circuits at 110 volts. There are two distributing switchboards arranged in the basement, one being for the arc and the other for the incandescent lamps. The main brought in from the street is divided into two cables for each pole, passing through a meter to the distributing boards. Between the meter and the main is arranged a double pole switch, so that the current may be switched on to the boards or disconnected from them, as desired. The arc switchboard is fitted with suitable cut-outs, rheostats, switches, meters, &c., whilst on the glow-lamp board there are only four main switches and four main cut-outs. The arrangement of a circuit for every two arc lamps permits of any two being extinguished, as may be desired, though this method is not so satisfactory as multiple arc distribution.

**The Electric Light in Belgium.**—The Belgian town of Ninove, situated about 15 miles to the westward of Brussels, is the first in that country to adopt the electric light. The concession granted to the gas company, and, by-the-way, Ninove was the first town in Belgium lighted by gas, expired on the 30th of September last, and the municipality, having decided to abandon the employment of gas, has entered into a contract for 30 years with an electric lighting company of Brussels. The lighting is to include streets, squares, and public places, as well as the supply of electric light to private dwellings. The installation comprises two large boilers, two Ridder engines of 20 H.P. each, two Siemens dynamos of 16,000 watts, and two batteries of Tudor accumulators capable of feeding 600 lamps for six hours. The distribution is effected by means of overhead wires. These are bare, of bronze, and 3·5 mm. diameter. They are carried on porcelain insulators supported by iron brackets. The public lighting consists of 120 lamps of 25 candles, mounted on the old gas lamps. For private lighting, the electric current will be supplied at 9 centimes per 100 watt-hours at a tension of 110 volts. The cost will be rather less than that of gas, which has lately been charged at Ninove at the rate of 18 centimes per cubic metre.

**The Electric Light at Chagford.**—A woollen factory, which has been unoccupied for some years, in this picturesque Dartmoor village, has been leased by Mr. G. H. Reed, millwright and machinist, who intends to utilise the water-power and wheel in his business, and hopes to supply the electric light to the inhabitants, using the water-wheel to work the dynamo. He gave an experimental installation last week, using Joel's shunt-wound dynamo, 100 volts 30 ampères, giving 40 16-C.P. Edison-Swan lamps. The brilliant, soft light was highly appreciated by the visitors, contrasting, as it did, most favourably with the gas supplied at Chagford. An electric lighting company is being formed, and it is expected that ere long Chagford will have a permanent installation.

**City and Guilds of London Technological Institute.**  
—The report of this institute for 1890 shows the following results of the examinations as regards the electrical subjects :—

	Number of candidates' papers in 1890.	Honours.			Ordinary.			Total.		Percentage of failures.
		1st.	2nd.	3rd.	1st.	2nd.	Fail.	Pass.	Fail.	
Electro-Metallurgy	19	1	5	3	2	2	6	10	9	47·3
Elec. Engineering—										
A. Telegraphy ...	117	17	3	3	24	23	47	67	50	42·7
B. Electric Lighting, &c. ...	256	5	16	32	66	86	51	173	83	32·4
C. Electric Instrument making	13	...	2	...	4	7	...	13	...	00·0

	No. of candidates in each subject in 1889	No. of candidates in each subject in 1890.	No. passed this year for first time.	Number, having previously passed, have this year.		
				Passed in a higher grade.	Gained a higher place in the same grade.	Gained no higher place.
Electro-Metallurgy	22	19	3	5	...	2
Elec. Engineering—						
A. Telegraphy ...	127	117	41	13	8	5
B. Electric Lighting, &c. ...	204	256	141	12	9	11
C. Electric Instrument making	15	13	12	1	...	...

	No. of candidates.	A <sup>o</sup>		No. of candidates passed.	A <sup>o</sup>		Percentage of failures.	
		A <sup>o</sup>	B <sup>+</sup>		A <sup>o</sup>	B <sup>+</sup>	A <sup>o</sup>	B <sup>+</sup>
Electro-Metallurgy	19	12	7	10	6	4	50·0	42·8
Elec. Engineering—								
A. Telegraphy ...	117	99	18	67	56	11	43·4	38·8
B. Electric Lighting, &c. ...	256	174	82	173	116	57	33·3	30·4
C. Electric Instrument making	13	5	8	13	5	8	00·0	00·0

° Taught in classes receiving grants on the results of the examination.  
† "External Candidates" taught in other institutions, or prepared by private study.

It will be seen that a very large increase in the number of "Electric Lighting" candidates has taken place.

**The Electrical Trades Union.**—Mr. J. Burns, L.C.C., addressed a meeting at the Bricklayers' Hall, Southwark Bridge Road, last Saturday night, held with a view to inducing non-members to join the Electrical Trades Union. He said he regretted that a Union had not been formed before, because instead of prices and wages being increased, they had, in some cases, been reduced, and boy, girl, and women labour had been introduced. The electrical trade was still in its infancy, and the business must extend. Electric lifts, motors, trains, and other methods of transmitting power would soon be adopted, and Vestries and Town and County Councils would, ere long, undertake public lighting. With the inception of electric lighting, he hoped the men who were engaged in the electrical trade would do everything in their power to help men like himself, who were members of public bodies, and who were determined to see that in any scheme of the kind Trades Union clauses were agreed to. It was a splendid opportunity for them to do something for themselves. They could fix the rates of wages, the hours of work, and the conditions of labour under any standard they thought fair and right if they had the courage. They had a splendid future before them; but if they did not take advantage of the opportunity, they deserved to remain in the condition they now were. Mr. Burns also pointed out to his hearers the advantages of Trades Unionism, and a resolution in support of the Electrical Trades Union was then proposed by Mr. A. J. Walker, and carried unanimously.

**Siemens & Halske.**—The taking over of the electrical works at Vienna, belonging to the Berlin firm of Siemens & Halske, as well as the Buda-Pest electric railway, to which we alluded last week, is now an accomplished fact. A limited company is to be formed by the Anglo Bank, Mr. Siemens becoming a managing director of the new company.

**A Cable Wanted in Paraguay.**—The Hon. F. J. Pakenham, British Minister to the Argentine Republic and Paraguay, says, "A want very largely felt at Asuncion is regular telegraphic communication with Monte Video or Buenos Ayres, and so with the world in general. At present (August, 1890), as in 1886, the telegraph line stops on the coast of the Argentine province of Corrientes, the missing link between which and the line in Paraguay being furnished by a person of apparently somewhat lethargic habit, whose movements on the Parana in a canoe seem rather to depend on the rule of *avoidsupois*, as applied to the bundle of telegrams whereof he is bearer, than to the urgency or value of the messages themselves. Doubtless, however, an improvement will be apparent in this direction ere long."

**Simple Pole Finder.**—In the New York *Electrical Engineer*, Mr. Arthur J. Newell publishes, as the result of some considerable experimenting, an account of a pole tester which he thinks will be of interest to many people. The invention consists in saturating litmus paper with sulphate of soda and drying. When the paper is to be used it is wetted, and on the application of the wires to be tested a red spot on a blue paper represents the positive pole; if a red paper is employed, then a blue spot will show the negative pole. Mr. Newell is probably unaware that a paper for pole-finding was brought out and placed on the market two or three years ago by Dr. Wilke, which paper has several advantages over the litmus preparation, its colour being white, finely contrasting with the rich crimson stain produced by the negative wire.

**Overhead and Track Wiring for Electric Railways.**—The superintendent of the Albany Railway, Mr. W. H. Cull, says that too much attention cannot be paid to overhead construction and track-wiring. The insulation of the hangers should be capable of eliminating moisture, and glass or mica has given most satisfaction. Insulation cannot be too good. The trolley wires should be divided in sections, for the greater facility in locating any fault, and, if possible, each section should have a separate feeder wire; a circuit switch at the generating station would enable the attendant to pick out the faulty section while still retaining the rest of the circuit in working order. Track wiring and ground connections are the most important factors in the operation of an electric road. The return wire should be of ample section, connected to each rail twice. All joints to be well soldered and wiped. The Albany Railway has, in addition to these arrangements, copper ground plates at intervals of 1,000 feet, and at a sufficient depth to insure their being in permanent moisture. The resistance thereby is so low that no leakage interferes with telephone circuits, neither is a metallic return requisite from the electric road to the power station more than a mile away.

**Halifax and Bermudas Cable Company.**—The daily journals announce that the Halifax and Bermudas Company's cable has been duly tested, and a certificate granted by the Government, who paid the first quarterly instalment last week, in terms of their agreement with the company.

**Tenders Wanted.**—For providing and fixing electric bells to firemen's houses at Pontypridd. Particulars of the secretary, Mr. E. W. Rees, Pontypridd.

**The Coefficient of Self-Induction.**—We observe that the "Henry" has been introduced into a scientific paper printed by an American contemporary as the title by which the coefficient of self-induction is to be known. Probably it will not be long before it will be disseminated throughout the scientific world as the accepted term for that coefficient.

**Price of Incandescent Lamps.**—In the home of free trade, England, the unfortunate monopoly in the manufacture of incandescent lamps keeps up the price of lamps to an almost prohibitive figure. In the United States, on the other hand, notwithstanding the great increase in the value of platinum, 16 C.P. lamps are selling at 44 cents each. The platinum wires now cost nearly three times what they did formerly, but in spite of this extra expense, competition compels, and the use of machinery enables, the manufacturers to quote low and still retain a profit. Red-hot hairpins should become things of the past. Brilliancy, and economy in consumption of power, will be esteemed more and more as the essential qualities of an incandescent lamp.

**Telephone between Paris and London.**—The French section of the telephone line and cable which is to connect London with Paris has been completed. It consists of two overhead bronze wires, parallel, and crossed at intervals to diminish the effects of inductive disturbance.

**Memorandum for French Elmore Shareholders.**—You paid the Foreign and Colonial Company £116,875 in cash and £66,500 in shares for the privilege of your company's existence. A few months afterwards you receive a circular from your directors, congratulating you on the fact that the Foreign and Colonial Company has arranged to hand you back £50,000 of the money you had paid them in order to add to your available working capital; you to pay equivalent to over  $7\frac{1}{2}$  per cent. per annum interest, and to issue debentures which presumably give the holders for £50,000 a first charge on what you have paid the same organisation £116,875 for (cash only), as well as a charge on any property your own further expenditure may create.

**A Chair of Industrial Electricity at the Paris Conservatoire of Arts and Sciences.**—The Minister of Commerce has just created, at the Conservatoire of Arts and Sciences, a chair of industrial electricity. The Academy of Sciences will be invited to present a list of candidates for the new chair.

**Electrical Fittings.**—One of our young, and therefore energetic firms of electrical engineers, Messrs. Arthur B. Gill & Co., of 4, Bombay Street, Bermondsey, S.E., writes to draw our attention to the extensive and convenient showrooms lately acquired by them at 36, Parliament Street, Westminster, S.W., for the exhibition and sale of their electrical manufactures and fittings—of everything, in short, connected with the uses of electrical energy. It is intended to keep a large stock of goods at these showrooms ready for immediate delivery, and special attention is desired, firstly, to a varied and comprehensive selection of artistic electric light fittings; secondly, to a stock of Henley's electric light wire and cables in all the leading types and sizes.

**North-East Coast Engineers.**—We have received the list of meetings of the North-East Coast Institution of Engineers and Shipbuilders. A good programme is promised, more of interest to shipbuilders than electrical engineers. Mr. W. C. Mountain reads a paper on "Electrical Engineering" on March 9th.

**Institution of Electrical Engineers.**—Among those who have accepted the invitation of the President and Council to the annual dinner on the 20th inst. are the Postmaster-General, the Attorney-General, the Presidents of the Royal Society, the Chemical Society, and the Institution of Mechanical Engineers, and the Vice-Presidents of the Institution of Civil Engineers, Sir Arthur Blackwood, the Astronomer Royal, and Dr. Coleman Sellers, one of the members of the International Niagara Commission. We understand that in anticipation of the large numbers who are expected to respond to the invitation of the President and Mrs. Hopkinson on the evening of the 19th inst., on the occasion of the President's *soirée*, the Prince's Hall has been engaged, in addition to the Galleries of the Royal Institute of Painters in Water Colours.

**Personal.**—Messrs. J. D. F. Andrews & Co. have purchased the goodwill and assets of the firm of Messrs. White, Romanze & Co., of Kingsbury Road, Dalston, and 3 and 4, Great Winchester Street, E.C., who have been carrying on a considerable business in the manufacture of arc lamps, switches, &c., and also telephones, type-printing instruments, and electric bells, besides having many important electric light contracts.

**Long Distance Telephony in Italy.**—A fortnight ago a series of experiments was conducted at the chief telegraphic office in Rome with a new telephone line between that town and Albano, a distance of 20 miles, or 40 in all, the circuit being metallic throughout. The trials were successful.

**Mr. Lee Baptý Arrested.**—Mr. Lee Baptý, the late manager of the Edinburgh Exhibition, was arrested at Waverley Station, Edinburgh, on Saturday night, as he was about to take his departure to the south. The arrest was made under a warrant, to prevent Mr. Baptý leaving the country until he had paid or found security for his contribution of £500 to the guarantee fund of the exhibition. Security was promptly found and he was released. Since then he has written an indignant letter to the *Standard*.

**The Asbestos-Faced Valve.**—We omitted to say that this article, described in our last number, will be placed on the market by the Bell's Asbestos Company, Limited.

**Honours for the Compound-Winding Advocate.**—Mr. Graham Murray, who so ably conducted the respondents' case in the compound winding, has been appointed Sheriff of Perthshire.

**Railway Stores Wanted.**—The Cheshire Lines Committee require a supply of telegraph instruments, wire, and materials. Patterns can be seen, and specifications with forms of tender obtained, upon application to Mr. S. S. Barton, Cheshire Lines, Warrington.

**Anglo-American Telegraph Company, Limited.**—This company has opened an office for the reception and delivery of telegrams at No. 2, Northumberland Avenue, Charing Cross, thus placing the West End of London in direct telegraphic communication with New York, Canada, and all other places in the United States, West Indies, &c.

**A New Professor.**—Mr. J. Swinburne has just been dubbed "Professor" Swinburne by the *Elektrotechnische Zeitschrift*. This gentleman has evidently risen in the estimation of Mr. F. Uppenborn, though he may perhaps not care much for the "promotion." Mr. Swinburne's American "professorship" is a matter of longer standing.

**The Bradford Free Library.**—The museum and three top landings of the staircase of this library are now provided with the electric light. The result has been eminently satisfactory, both as regards quantity and quality of the light produced. The installation consists exclusively of 16-candle incandescent lamps, which are equally distributed over the room by means of pendant wires. The installation was completed on December 23rd, 1889, and has been working without the slightest hitch ever since that date. It has been decided to light by electricity the whole of the premises.

**Underground Telephony in Germany.**—The results obtained with the underground telephone circuits in Berlin have been so satisfactory that the Imperial Post Office authorities are now making experiments with long-distance underground wires. There are already in operation a telephone cable between Berlin and Küstrin, a distance of 57 miles; and a line from Berlin to Hamburg, 60 miles being overhead and 25 miles underground, whilst shortly the latter will be extended to 186 miles in length. The results with these long-distance wires are said to be very favourable.

**A 200,000-watt Arc Lamp.**—In a recent issue of *La Lumière Electrique*, M. de Fonvielle, in describing the electric lighting of the Gran Plaza de Toros in Paris, to which we refer on another page, states that the arena is partly lighted "by a Patin arc lamp taking 400 ampères at 500 volts, giving 8,000 C.P., and absorbing 50 H.P." A representative of a contemporary has, however, failed to find this large lamp, and states that only Cance arc lamps are used to light the arena. He demands the confirmation of these extraordinary figures.

**Porcelain Fittings for Electric Lighting.**—Messrs. Taylor, Tunnicliff & Co., who are extensively engaged in the manufacture of porcelain fittings for the electric lighting trade, have recently completed special machinery for overcoming a trade difficulty, which will doubtless lead to very satisfactory results, and supply a want severely felt by electricians engaged in fitting up these goods with the necessary metal work. We refer to the tapping with a very fine thread the small holes in porcelain switches, cut-outs, ceiling roses, &c., thereby enabling manufacturers to fit these articles up with metal work without the objectionable metal nuts, &c., at the back of such fittings, which have hitherto been a fruitful source of mishaps.

**Notice of Removal.**—Messrs. Davey, Paxman & Co. inform us that they are removing their London offices to larger and more convenient premises, at 78, Queen Victoria Street, E.C.

**Accumulator Traction in Paris.**—The action taken about a year ago by the French Electrical Accumulator Company in putting into service several accumulator cars on the Levallois-Madeleine tramway in Paris has now been followed by the company for the electrical working of metals. This company is now exploiting a tramway between the Palais de l'Industrie and the Place de la Concorde by means of a storage battery car fitted with Laurent-Cely accumulators. A noteworthy feature is that the car runs upon a Decauville tramway of the 2-foot gauge. The car is mounted upon two axles, and carries two Hillairet motors of 6 H.P. each. Each motor drives, by means of gearing, one of the axles, the reduction in the speed being in the ratio of 10 to 1. The battery consists of 64 cells containing 11 plates. These cells are placed in eight boxes, and the total weight of the car, without passengers, is 4½ tons. By means of a suitable switch the cells can be put in series or in parallel. On starting the car the current discharge is 90 ampères, and in ordinary running the consumption is 45 ampères.

**The Woking Electric Supply Company.**—This company has commenced operations, and applications have been received for nearly 700 lights. The Electric Trust erected the station and supplied the plant, and the whole of the electrical arrangements were designed and carried out by Mr. J. Appleton, of Guildford and London. The provisional order enables the company to charge 10d. per Board of Trade unit for electric current, but the price has been fixed at only 8d., being equivalent to about 8s. per 1,000 feet of gas. The company has made provision for using the light from half an hour before sunset until midnight, but as soon as it finds that there is a demand for light at a late hour, it will be prepared to extend their time of running.

**The Pacific Cable.**—In a former issue we mentioned that Sir John Pender was reported to have announced his intention of visiting Hong Kong, next year, *via* Canada, and of interviewing, *en route*, Mr. Sandford Fleming. The following is an extract from his letter :—“ . . . travelling by the Canadian Pacific line, when I hope to inspect that wonderful undertaking in which you have played such a prominent part, and at the same time discuss with you the best means of establishing closer telegraphic communication between Canada and the Australian Colonies, when the time is ripe for carrying out the work.”

“If the various governments interested are determined to have a line across the Pacific, and are prepared to incur the requisite expenditure for the purpose, I am quite ready, as I have always told you, to co-operate in carrying out the work on fair and reasonable terms. In this way the object might be obtained more easily and economically than if third parties were employed.” There is a charming frankness and *naïveté* about this last remark which will no doubt commend itself to the “third parties”; and we would ask how long is it since certain persons have become converted to the belief that no insuperable physical difficulties stand in the way of laying a cable across the Pacific Ocean? Mr. Fleming, in his reply, is reported to have said that the means taken to establish the new telegraphic communication are entirely secondary, provided the new lines be secured.

**The Lane-Fox Patents.**—Some of our readers will be interested in an advertisement appearing in the centre of this paper, with regard to the subject of which we are given to understand that the only claim which the Lane-Fox Electrical Company has so far decided to enforce has been based on Mr. Lane-Fox's leading patent, No. 3,988\*\* of 1878. But this moderation was largely misunderstood, and attributed to different motives; and as the company also finds a disposition amongst certain members of the trade to evade the matter at issue rather than to meet it fairly, the Lane-Fox Company has now determined to anticipate such attempts by enforcing the claims based upon letters patent No. 4,626 of 1878, for the use in connection with its system of shunt “electro-meters,” that is to say, of the class of instruments commonly known as voltmeters or potential electro-meters, with or without automatic attachments. We may also call attention to a slip of the pen in Mr. Lane-Fox's last letter to us, by which it is dated October 4th, by mistake for November 4th. This might lead some of our readers to look in vain for an article in the issue immediately preceding that date (October 4th).

**Lighting the Guildhall.**—On the occasion of the Lord Mayor's banquet at the Guildhall on the evening of the 10th inst., the hall was illuminated by about 500 incandescence lamps artistically attached to the gaseliers above the tables, and the excellent effect produced was greatly admired. The installation was carried out by the Brush Electrical Engineering Company at very short notice, and the result reflected great credit on all concerned.

**Efficiency of Combined Engines and Dynamos.**—The following letter from Messrs. Sautter, Harlé and Co. appeared in the last issue of a valued French contemporary :—In *L'Electricien* of November 1st are published the results obtained in recent trials, made in England, of a system composed of an Edison-Hopkinson dynamo, worked directly by a Willans engine. The satisfactory results obtained are not surprising. In France renderings quite as high are obtained. The following figures, which may perhaps be of interest to your readers, have been arrived at under the supervision of naval engineers in trials of the systems of motors and dynamos, working directly, constructed by us in 1890 for lighting the ironclad *Neptune*. They may serve for purposes of comparison. The dynamos of the *Neptune* supply a current of 75 volts and 200 ampères, or 20 electrical H.P. at 350 revolutions per minute. The consumption of steam at a pressure of 6 kg. per cm<sup>2</sup>, instead of being 11.3 kg., is less than 11 kg. per electrical horse-power hour measured at the terminals of the dynamo. A direct trial by the Prony brake, on the motor, showed a consumption of 8.9 kg. of steam per *effective* horse-power hour, instead of 9.8 kg. per *indicated* horse-power. The consumption is therefore less than in the case quoted, and the difference will seem all the more worthy of mention when we consider that the system gives only 20 horse-power instead of 72, that the pressure of steam is 6 kg. per cm<sup>2</sup> instead of 8, and that the dynamo makes 350 revolutions per minute instead of 430.

**Telephone Working.**—Mr. J. J. Carty, of the Metropolitan Telephone and Telegraph Company, writes to us under date, November 1st, as follows :—My attention has been called to an editorial note in your issue of October 17th, referring to my remarks at the Detroit Telephone Convention, in which it is stated that I seemed to be unaware that the system of bridging bells invented by me has been in use for many years in the British Post Office telephone service, and that it is described in the *Telephone*, by Preece and Maier. I would call your attention to the fact that, as shown by the official report of the convention proceedings and all published accounts of my remarks, I did not claim any novelty for the bridging system *per se*, being well aware that it has been in use for years both in Europe and in America. My invention, however, relates to a specially designed bridging magneto bell, by means of which the talking and signalling on a line containing 20 stations equipped with this bell are equally as good as with a line containing only two stations. These results are not attainable with the ordinary form of magneto bell. The details of the construction of my bell were not described by me at the Convention, as an application for patent rights was then pending in the U.S. Patent Office. So far from their being any description of a bridging system employing magneto bells in the *Telephone*, it is expressly stated in that work that the magneto bell has not been adopted by the British Post Office for telephone work, and there is no mention in the book of any method of connecting a number of stations with magneto bells by bridging the instruments across the circuit. In justice to myself, I must request you to publish this letter in your next issue, as if your editorial statement as to the absence of novelty in my invention is allowed to pass uncorrected, it might unfavourably affect my interests in the matter of the disposal of the European rights to use the bridging magneto.

**The Popp Compressed Air System.**—A German contemporary waxes wroth because the commune of Rixsdorf, near Berlin, has, on the advice of an Imperial architect, resolved to introduce the Popp compressed air system for lighting and power purposes. The same journal, in referring to a circular issued from Lucerne inviting subscriptions to a proposed Popp central station in that town, asks what authorities have spoken favourably of the system.

**Civilian Electricians in War Time.**—In Lient. Bradley A. Fiske's paper, published in another column, the author argues that as the force comprised by the standing regular army and navy is so small, it would only serve as a nucleus around which the fighting forces could be formed. Since the applications of electricity have extended to so many branches of military and naval arts, and have, in fact, become absolute necessities, the supply of competent officers and men, insufficient as it is in time of peace, would prove utterly inadequate in case of war. Lient. Bradley enumerates the many and varied uses of electricity in navigation, gunnery, torpedo work, &c., and proceeds to point out where, in his opinion, the civilian could be best employed. He suggests that on board electrical torpedo launches and electrical picket boats, at fish-torpedo stations, in submarine mining both for harbour and coast defence, in addition to signalling work by telegraph or telephone, the civilian has his proper sphere. But, he adds, the civilian could also be advantageously employed on ships of war for the reason above stated—the insufficiency of a trained and competent regular staff. The author proposes that at all important ports there should be a corps of electrical engineers, drilled to some extent, and attached to and embodied with the national guard. The higher ranks would be instructed in navigation, gunnery, surveying, &c., while the lower would be taught the handling of apparatus.

**The Spanish-Morocco Cables.**—We understand that the contract for connecting Spain with her settlements on the coast of Morocco by submarine cables has been given to Messrs. Pirelli and Company, of Milan. It will be remembered that the original decree was withdrawn, and a new one issued, upon which the present contract has been made. Some of the conditions are slightly altered, the maximum price per mile of cable being now fixed at £160, payable in ten years by yearly instalments. The contractor during this period has to maintain the cable at his own cost. The sections between Almeria—Alboran and Alboran—Melilla must be laid and working within three months from date of signing contract; the other sections within six months. The lengths specified for each section differ slightly from what were given in the former decree. No stipulation is made as to quantity of each there should be laid, the decision on this point being left in the hands of the commission appointed by the Spanish Government.

**The Telephone in France.**—Twenty-eight towns in the departments of France have acquired, through their municipalities, a telephone service. In eight other towns the telephone lines are in construction, and will be completed in two months' time. Plans are being got out and surveys made for supplying 13 more towns with telephone systems. Of interurban systems there are only two actually working; there are seven in construction, and ten under consideration. Seven towns are connected with Paris by the telephone, and there are four more in course of being joined to the capital. In Algeria, the only two towns possessing the telephone are Algiers and Oran.

**The Late Electric Light Accident in Paris.**—At the last sitting of the Paris Municipal Council that body was engaged in considering the explosion following a fire in the cellars of the Grand Café. From some explanations given by the Secretary-General of the Prefecture of Police, though the enquiry is not finished, it appeared that the responsibility for the accident was due to the electric light company which occupied the underground portion of the premises. This company, the night before the accident, replaced the man who had formerly been in charge by an inexperienced man. The conclusion which the Council arrived at was as follows: The Prefecture of Police and the Prefecture of the Seine rejecting altogether the responsibility of

surveillance, the Council voted the following order of the day, proposed by M. C. Laurent: "Considering to what dangers the installation of the electric light in Paris may give rise to, this body expresses a wish that Parliament, by a special law, will assimilate the electrical industry with those which are looked upon as dangerous and subjected to the incessant surveillance of the Prefecture of Police."

**Electric Launch in Milan.**—The Franco-Italian Industrial Electrical Company, of Milan, is demonstrating the capabilities of an electric launch in the docks of the Porta Ticinese. The launch is 24 feet long by 5 feet wide, and will carry 12 passengers. It contains a battery of accumulators, and an Immisch motor of 1½ H.P., the speed of the launch being 8½ miles an hour.

**The Electro-Deposition of Copper.**—We have not yet had any further data on this subject from Mr. W. Stepney Rawson.

**Quick Cable Service.**—The following is taken from the Montreal *Daily Witness* of October 30th:—"One of our local magnates sent a cablegram to London *via* the Commercial cable this morning at 10.27, and at 10.40 he had a reply, just 13 minutes. In this time the message was sent from Montreal to Canso, thence to Ireland, where it was reported to London. A transaction was effected on the London Stock Exchange, the reply written and came travelling back again, reaching the sender in 13 minutes. The gentleman could scarcely credit it, but on examination of his sent message and his reply thereto found the facts to be as above."

**The New Thomson Alternating Meter.**—Recognising the value of a simple and reliable device for measuring current, Prof. Elihu Thomson has in the past devoted not a little attention to the design of various meters, among which probably those of the oscillating type, in which a volatile liquid is employed as the moving force, as it were, are best known. Recently, however, says an American exchange, Prof. Thomson has devoted particular attention to the construction of a meter which shall be adapted to both continuous and alternating currents and at the same time indicate not only the consumption of current, but give it in the value of the pressure on the mains; in other words, a power or wattmeter. The manner in which Prof. Thomson has worked out this problem is highly ingenious and is apparently based on simple principles. The problem to be solved evidently was to construct a motor in which both the pressure and the current should be the factors determining the speed and a device embodying a retarding force which should vary in the direct ratio with the speed of the machine. The relative disposition of field and armature of the motor and their connection with the working circuits fulfils the former conditions, while the disposition of the copper disc retarded by the encircling magnets fulfils the second. With constancy of magnetism assured in the permanent magnets and friction reduced to a minimum, as it appears to be in this instrument, its accuracy ought to be very high. Not the least interesting point in connection with it is the quality it possesses, as exhibited by the curve, of affording practically uniform readings for both continuous and alternating currents. We hope to illustrate this apparatus in our next issue.

**New Study in Natural History.**—In a letter to the New York *Electrical Engineer*, "Professor" J. Swinburne says:—"We are sending the Westinghouse Company a 50 lighter (transformer) to test. In a few weeks the Westinghouse advertisement will read, 'It will pay you to throw away our converters and substitute the Hedgehog make.'" This animal is an amusing little cuss.

**The New Electric Railway.**—It is stated that the new City and South London Electric Railway, which was formally inaugurated by the Prince of Wales a few days ago, will be opened to the public on the 26th inst. Let us hope, however, that no premature start will be made. Better wait several weeks longer if any uncertainty exists, for any little hitch, which can readily be overlooked on an inauguration day, will not, if allowed to occur in actual working, meet with the same sympathetic feeling from the travelling public.

**Electric Lighting in Germany.**—According to statistics there were 21 central electric lighting stations in Germany in the year 1889. The horse-power employed is given as follows; Barmen, 600; Berlin, 10,000; Brunswick, 2,000; Bremen, 600; Breslau, 500; Cologne, 500; Darmstadt, 450; Dresden, 500; Eberstadt, 100; Elberfeld, 325; Ems, 100; Frankfort, 1,000; Gærlitz, 450; Halle, 550; Hamburg, 1,200; Königsberg, 300; Zubeck, 300; Magdeburg, 500; Mulhausen, 300; Olmütz, 300; Strasburg, 400; the total amounting to 20,975 H.P.

### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**International Okonite Company, Limited.**—The statutory return of this company, made up to the 23rd ult., was filed on the 30th ult. The nominal capital is £340,000, divided into 11,334 ordinary, 11,334 preference, and 11,332 vendors' shares of £10 each, the latter being considered fully paid up. Upon the ordinary and preference shares £7 per share has been called up, the calls paid amounting to £147,187 17s. 6d., and unpaid to £11,488 2s. 6d.

**S. Z. de Ferranti, Limited.**—An agreement of 30th June, filed 25th ult., provides for the purchase by the company of the business of S. Z. de Ferranti, carried on at Charterhouse Square, at Deptford, and at St. Benet Chambers, Fenchurch Street. The purchase consideration is £99,930, payable as to £19,930 in fully paid preference shares, and £80,000 in fully paid ordinary shares.

**Stamford Hill, Tottenham, and Edmonton Electric Light and Power Supply Company, Limited.**—The name of this company has been changed to the West Metropolitan Electric Light and Power Company, Limited, in accordance with a special resolution passed at a meeting of the members held on the 21st ult., and confirmed at a meeting held on the 5th inst.

**Woodhouse and Rawson United, Limited.**—The annual return of this company, made up to the 24th ult., was filed on the 6th inst. The nominal capital is £350,000, divided into 40,000 ordinary and 30,000 preference shares of £5 each, the whole of which are taken up; 8,564 ordinary and 9,936 preference shares are considered as fully paid up. Upon 31,436 ordinary shares £2 10s. per share has been called up, and upon 20,064 the full amount has been called. The calls paid (including £85 paid in advance, amount to £178,826 10s., and unpaid to £180. Three ordinary and 20 preference shares, upon which £11 10s. has been paid, have been forfeited.

**Crossley Telephone Company, Limited.**—The annual return of this company, made up to the 25th ult., was filed on the 5th inst. The nominal capital is £100,000, divided into 5,000 "A," 12,500 "B," and 2,500 "C" shares of £5 each. The shares taken up are 607 "A," 120 "B," and 350 "C," all being fully paid up.

**Taunton Electric Lighting Company, Limited.**—An agreement of 28th ult. (filed 6th inst.), cites that the Laing, Wharton, Down Construction Syndicate is now supplying to the company, certain plant and machinery for the company's new dépôt at Taunton and for other works connected with the company's lighting operations at Taunton, the total cost of the same being £1,230. It has been arranged that one-half the amount shall be paid in fully paid shares of the company, and accordingly, under this agreement, 123 fully paid shares of £5 each will be allotted to the syndicate.

**Laing, Wharton and Down Construction Syndicate, Limited.**—The annual return of this company, made up to the 1st August, was filed August 15th. The nominal capital is £40,000, in £100 shares. 399 shares are taken, 133 of which are considered as fully paid up. Upon 266 shares the full amount has been called and paid.

**Allan Everett & Sons, Limited** (metal manufacturers, electrical engineers, &c.).—The statutory return of this company, made up to the 16th ult., was filed on the 21st ult. The nominal capital is £300,000 divided into 20,000 ordinary and 10,000 preference shares of £10 each. The shares taken up are 12,000 ordinary and 10,000 preference; 4,000 of the former and 3,300 of the latter are credited as paid up to the extent of £32,000 and £33,000 respectively. Upon 8,000 ordinary shares £8 per share has been called, and upon 6,700 shares the full amount has been called. The calls paid amount to £131,000. Registered office, Adderley Street, Birmingham.

### CITY NOTES, REPORTS, MEETINGS, &c.

#### The Western and Brazilian Telegraph Company, Limited.

THE report of the directors presented at the twentieth ordinary general meeting of the company yesterday states that the total earnings amount to £89,846 13s. 9d., as against £86,555 17s. 10d., an increase of £3,290 15s. 11d. compared with the half-year to June 30th, 1889.

The working expenses amount to £40,509 13s. 3d., as against £39,104 15s. 5d., an increase of £1,404 17s. 10d. This increase is attributable to a larger sum having been written off the steamers on account of depreciation (£1,031), to the rise in the price of coals, to the opening of a new station and to the larger volume of traffic.

Including the amount brought forward from 1889 (£3,248 16s. 6d.) and the dividend received upon the shares held in the "Platino" Company to June 30th, the balance to the credit of the revenue account is £59,970 17s. from which has to be deducted £13,220 for debenture interest, leaving £46,750 17s., of which £7,500 has been placed to the renewal fund and £5,880 to the debenture redemption fund. This leaves £33,370 17s. The directors recommend the payment of a dividend of 6s. per share, free of income tax, on the ordinary shares for the half-year, being at the rate of £4 per cent. per annum, carrying forward £5,751 7s. At the corresponding period last year the dividend was at the same rate.

Since the last half-year's report 30 "Platino" shares have been exchanged for 18 shares of this company.

The dividend warrants will be posted on November 14th.

An agreement for the absorption of the Montevidean and Brazilian Telegraph Company, Limited, will be submitted for the approval of the meeting. The undertakings are so closely allied that it is most desirable they should be brought under common control, and it is now proposed to purchase the above company by an issue of 5,300 ordinary shares of £15 each in the Western and Brazilian Telegraph Company, Limited, ranking for dividend earned after January 1st next. The agreement at present subsisting provides for the payment to that company of a percentage of the gross receipts of the Western and Brazilian Telegraph Company, Limited. This payment, forming a portion of the amount paid to the London Platino-Brazilian Telegraph Company, Limited, is a charge coming between the A and B debenture issue of the Western and Brazilian Telegraph Company, Limited. Consequently upon the arrangement now proposed, the proportion of this charge, hitherto paid to the Montevidean Company, will disappear.

The directors have the pleasure to state that after long and difficult negotiation, the Government of Brazil have authorised the

company to lay alternative cables. The thanks of the company are due to the Government of the United States of Brazil for this decision. Steps will be now taken to lay the lines immediately necessary.

The Chairman, after referring to the figures given in the report, said he would turn to what he would call the political aspect of the period under review. Shareholders would remember that when they met twelve months ago they were in a parlous condition. The Brazilian Government had absolutely refused to permit them to lay the loop cables; in face of that prohibition it was quite impossible to proceed. In other respects, too, the position at Brazil was not satisfactory. That was stating it in as mild a way as he could put it. Immediately after the last meeting there was a change of government in Brazil, and instead of dealing with an Empire, they had to treat with a Republican Government. He was glad to say their experience in regard to the loops was more satisfactory than with the previous Government. They firstly endeavoured to do all they could to obtain the support of the British Government. Lord Salisbury met them in a very fair spirit, and enquired fully into the matter, the result was in the company's favour, and they obtained the moral support of our Government. He considered it had done them a great benefit. Their representative in Brazil had been exceedingly active, and conducted the negotiations to the satisfaction of the board. With a great empire like Brazil, neither the company nor any Government could bring pressure to bear, they could only convince, and fortunately the strength of the case and the weight of the evidence did convince. He was pleased to say that they had authorised the laying of the cable. They were not to suppose that this cable would bring in any extra revenue, that was not the object, it was to enable them to fulfil their concessional obligations more effectively, and at the same time to safeguard the lines against interruptions. Then there was the forfeiture clause in the agreement, which was rendered safe by this extra cable. The special question before them that day was the purchase of the Montevidean Telegraph Company. At the present time they had an agreement with the Platino Company and the Montevidean. The latter company had a second charge upon their receipts, and if the shareholders approved, it was decided to absorb the interests in accordance with the statement in the report. In conclusion, he proposed the adoption of the report and accounts.

Mr. Earle seconded, and it was carried unanimously.

The Solicitor then read the proposed agreement, which met with the approval of the meeting, and the proceedings terminated.

### The Metropolitan Electric Supply Company, Limited.

SIR JOHN PENDER presided at the third annual meeting of the company, on Friday, at Winchester House. He said: The report will have explained to you our reasons for calling you together to-day. Under the Electric Lighting Act it is provided that companies with statutory powers must present their yearly accounts made up to December 31st to the Board of Trade not later than March 25th in the year following. You will remember that our company was formed in the autumn of 1888, and we naturally made up our first year's accounts to September 30th, 1889, and our general meeting was held to confirm those accounts in December last. The Board of Trade having intimated that they expected us in future to comply with these statutory requirements above referred to, we have found it necessary to alter the period of our financial year, which will end in future on the last day of December. We shall, therefore, call you together again in the spring for the purpose of submitting to you our accounts, and our meetings will henceforth be held in the beginning instead of the end of the year. I am glad to meet you to-day, for I am anxious to place before you such information as will enable you to share with the directors the confidence which they feel with regard to the position and prospects of the company. I have always felt, as chairman of other companies, that the more we strengthen the confidence between the directors and the shareholders the more smoothly we proceed and the more satisfactory is the business conducted. When we last had the pleasure of meeting you, I stated that we were supplying current for 15,000 lights, to 58 customers. We are now supplying current for 40,000 lights, to 300 customers. I may state that this number is largely in excess of that supplied by any other company in the United Kingdom, and that it is equal to about one-third of the total number of lights supplied in London by public companies. I am informed by our manager that we hold contracts for a further 10,000 lights, and that there are many more applicants who are negotiating with us for the supply. Indeed, I may say that it has been our experience that the number of applications grows steadily with and in proportion to our number of customers. I have in my hands a table showing the monthly increase of our lighting during the present year, which will give you some idea of the steady and assured growth of our business. I can also read to you a few of the testimonials we have received expressing entire satisfaction at the supply. That is another important point. I daresay you have all heard a great many complaints about the electric supplies of other companies. We have had nothing but complimentary letters from our various customers, which gives us after all the best assurance of the rapidly increasing confidence in our supply. I think it as well that I should read the testimonials, because they are important. Mr. Augustus Harris, of Drury Lane Theatre, says:—"I have no

hesitation in affirming that the electric light supplied by your company, the Metropolitan, is and has been in every way satisfactory, both as to quality and regularity." Mr. George Edwardes, of the Gaiety Theatre, says:—"In reply to your inquiry, the light you have been supplying is extremely satisfactory. There is not the slightest fault to find with it, the current being regular and the light brilliant." Mr. Kennedy, of the Exeter Hall, says:—"I am pleased to inform you that the installation of the electric light at the Central Young Men's Christian Association has proved a complete success. We are very pleased both with the continuity and the quality of your supply, and I shall be at all times pleased to afford any persons bearing your card an opportunity of viewing the light." Mr. Compton, of the Garrick Theatre, says:—"I beg to state that the lighting of this theatre is in every way satisfactory, both as to purity and regularity." Messrs. Hampton and Sons state:—"We have much pleasure in stating that the lighting of our premises upon the low tension system is most satisfactory, the whole 640 lamps giving a good steady light. We heartily congratulate you upon its success." I am just reminded by one of the directors, who is a great personal friend of Mr. Hare, of another excellent testimonial. Mr. Hare's statement as an actor was:—"I feel when I leave the theatre at night quite a different man from what I used to be when we had the gas. I find, because I breathe a pure atmosphere, that I can do my work better and more effectively, and altogether I find, even from a sanitary point of view, that it is immensely beneficial to theatres." You see I have not given you private testimonials, but those of our theatres, where it is so important that the light should not only be steady, but brilliant, and I think these evidences of what we are doing are a very striking proof of what we may expect in the future. I am now going to show you, gentlemen, the state of our lights, and how they have grown. On March 1st we had 16,000 lights, on April 1st 19,000, on May 1st 21,000, on June 1st 22,000, on July 1st 23,000, on August 1st 30,000, on September 1st 33,000, on October 1st 36,000, and on November 1st 40,000. You will observe that we have passed through the summer with a very fair average, and before the end of the year I expect to see at least 10,000 lights added. A glance at the map which we have prepared will show you the magnitude of our operations. You will notice the supply stations at Whitehall, Sardinia Street, Rathbone Place, and Manchester Square, together with the vast system of underground mains that have been carried out. Upwards of 40 miles of mains have been already made, and we roughly estimate that to complete our system at least double this quantity will be required. The following statistics on the subject of our areas may be of interest as showing their magnitude and importance. The average acreage is 3,105, houses 45,451, and the rateable value £4,500,000. The report states that we have obtained powers over Paddington. This district adjoins our other areas, and therefore will form part of our general system. We have obtained an advantageous site on the canal bank, and are about to commence active work, supplying, in the first instance, from our Manchester Square station. This will enable us to supply light immediately. I may here observe that we have no intention of applying for further districts at the present time. We do not consider that we shall be justified, with our present issue of capital, in incurring further responsibility and liability. We are satisfied that our present areas are amply sufficient both in size and importance to take up all our energies, and we believe that it is equally conducive to the interests of shareholders and consumers that we should develop the resources we have already acquired. Our capital at the present moment is £500,000. When I was examined before the committee which was appointed to inquire into the general electric lighting of London, I stated that I would not be satisfied as chairman of this company until our capital became at least £2,000,000. I hold precisely the same opinion to-day, after two years' experience of the work before us. I will now describe to you, in as few words as possible, the present condition of our supply stations. Our Whitehall station has caused a certain amount of disappointment owing to the fact that the large block of buildings called Whitehall Court, which it was originally constructed to light, and which we were under contract to supply as and when required, is not being occupied quite so speedily as we might have expected. Owing to this delay, we have not been able to utilise the station to its full capacity. We were, therefore, unable to count upon this station as a source of profit during the construction of our other stations, as at one time we had hoped to do. I may state that the Whitehall Court buildings are now being let satisfactorily, and I therefore hope that before long the station will be fully taken up. I informed you at our last meeting that we had given an order to double its capacity. This contract has been carried out. The machinery is now in working order, and we are ready to cope with any demand of it that may arise. We have at this moment 19,500 lights running from this station, and I may state that we have here a plant equal to supplying 50,000 lights. I very much hope that as many shareholders as possible will take an opportunity of visiting this station, as it will enable them to realise the magnitude of our undertaking. Orders to view our works can be had at the secretary's office. From this station one of the largest installations in London—that is, Drury Lane Theatre—is being lit. The next station that I shall refer to is Rathbone Place. I have already informed you of the circumstances which led us to purchase and develop this small station, which has existed for some time on this site. The new machinery which was ordered some time ago is now fast approaching completion; indeed, it would have been finished before now had it not been for many serious difficulties which have now, I am glad to say, been successfully overcome. These diffi-

culties were of a mixed character. In the first place, I daresay you know that if a man has a house alongside any electric installation, his belief is that he ought to bleed the company to some extent, on the ground that he is inconvenienced by the vibration. We have had injunctions without number, but all those injunctions were overcome in Rathbone Place. So much confidence have we in the value of this station that three days ago we purchased by auction the long lease of the building in which this station is situated. I may state that the price paid was a most reasonable one; in fact, we are advised that it is a great bargain, and the property will yield a very satisfactory return on the outlay. I may state that Rathbone Place is a most central station, and likely to give every light required. The number of lights we are now supplying from Rathbone Place is 6,000. This number could have been very largely increased, had it not been thought advisable during the construction operations to abstain from overloading this station. Manchester Square is the next station to which we attach very great importance. It is situated in the midst of the wealthy parish of Marylebone, and promises to be one of the most lucrative stations in our districts. You may remember that at the last meeting I informed you we had made advantageous terms with the London Electric Supply Corporation, by which we took over from them the existing network of mains in the Marylebone district. We were thus enabled to supply from this station the whole of the then existing demand as soon as our machinery was ready to run. By this means, although the machinery has only been at work for a period of four months, we are now supplying 11,000 lights. It is impossible to exaggerate the difficulties which are incurred in excavating the streets of London, and in avoiding the numberless pipes already laid. I may state that the whole of these works are being executed by our own men, under the superintendence of our engineering staff, and I can safely say that this is far more economical than that of employing contractors. These works have necessarily brought us into frequent contact with the local authorities, and with the County Council, and I should like to take this opportunity of expressing publicly our appreciation of the kindness and courtesy shown to us by the officials of these bodies. Turning to our financial position, I would remind you that owing to the circumstances under which we have called you together, we have no audited statement to submit. We have, however, gone very carefully into the matter, and I have no doubt that it will be satisfactory for you to hear that even with the necessarily small amount of our revenue at the close of last year and at the commencement of this, we have every reason to believe that we have more than paid our way. We are very pleased to be able to make this statement, for the following reasons, which we are anxious that you should carefully bear in mind. Our working expenses in the past, and even at the present, are, with one exception, the same, to all intents and purposes, as they will be when we are supplying double, nay treble, the number of lights which we are at present doing. Of course, the one exception is the item of coal. Otherwise, we have, at present, an engineering staff almost sufficient to cope with the maximum output we shall hereafter be called upon to supply. Hence the increase of working expenses bears no proportion to our increase in trade, and the larger our number of lights, the greater our profit on each light. The reason which makes it necessary to employ what may, at first sight, seem an excessive engineering staff at our stations, is that it is necessary that we should have a staff in the future sufficiently experienced to accept the responsibility which a full demand will impose; and it must also be remembered that our stations require almost as much supervision and attention now as at any time. I trust that I have made this sufficiently clear to you, because it will enable you to grasp some of our initial difficulties and to appreciate the importance of the statement that we have already made, that we are making a small profit. With the present large growth of business over what it was six months ago, and with an assurance of a continuous and steady increase from the present time, we believe that we are perfectly justified in stating, as we do in the report, that we look forward to a satisfactory dividend being earned during the ensuing year. I have heard some people say that a dividend might have been expected during the present year. I think this is a little unreasonable, inasmuch as the company has only been founded for a little more than two years, and has only been in possession of its Parliamentary powers for little more than one year. During this time the works which I have endeavoured to describe to you have had to be executed, and already we are able to announce that, with an average output during the present year of, say, 25,000 lights, and with our working expenses, as I have already endeavoured to show you, almost as heavy as they will ever be, we have run at a small profit. It does not, therefore, take much power of calculation to show that we may confidently look forward to a substantial return in the near future. I beg to move the adoption of the report and accounts.

Sir Robert N. Fowler, Bart., M.P., seconded the motion.

A Shareholder asked whether he understood that 30,000 lights represented £30,000.

The Chairman: Not necessarily. We are now selling our electricity by meter, and, therefore, it may be more or may be less. We must have a year or two's experience of how the meter works out before we can give a definite answer to that question.

The Shareholder: I wanted to know what the 100,000 lights mean.

The Chairman: We cannot answer that question yet, but if you ask my private opinion you might take it at about 10s. (A Member of the Board: More than that.)

A Shareholder: We shall get a key to it if you tell us the present revenue of the company.

The Chairman said he estimated the income of the present quarter at £10,000.

A Shareholder enquired whether the company was going to supply motive power as well as the light.

The Chairman replied that light was their primary object, and the demand was such at the present time that they had no time to turn their attention to supplying the motive power.

The motion was then put, and carried unanimously.

Mr. Giles, M.P., then moved the re-election of Sir James Anderson, Mr. J. Spencer Balfour, M.P., and Sir George Elliot, Bart., M.P., as directors of the company.

Mr. Dibley seconded the motion, which was agreed.

After the re-election of the auditors, a vote of thanks was accorded to the chairman and board, which was duly acknowledged, and the proceedings terminated.

### West India and Panama Telegraph Company.

IN accordance with the report published in our columns last week, the meeting of this company was held at Winchester House, on Wednesday, under the presidency of Mr. C. W. Earle. In taking the report as read, he said the report was the most satisfactory one which had ever been presented to the shareholders. It was not a very brilliant one at the best, and as long as the condition of the field remained as it is now, there was little probability, in his opinion, of its ever being a very brilliant result. Traffic receipts were slightly larger than before. Working expenses, other than repair, were less than usual. Repairs to cables were in excess of previous years, but this had the compensating advantage of their putting less to the reserve fund. They were within measurable distance of the riddance of the incubus that laid upon them in the shape of arrears of dividends on the preference shares. At the present time they owed £1 8s. 6d. per share on the second preference only, the total coming to £6,653. When they compared that with the £56,000 owed in 1884, he considered good progress had been made. At the request of the colonists, they had duplicated their lines. Although new traffic would not arise, there would not be the loss incident on interruption. The difficulty at Demerara was practically settled, and they would shortly lay a cable between Trinidad and Georgetown, Demerara. The ship, *Grappler*, was already lying in the Thames waiting for the cable. After referring to his watching the interests of the company at the Telegraphic Congress, he said traffic receipts were good and he was really beginning to have hope of a better state of things. But they must not run away with false impressions because they were coming out of bad times. Their receipts per mile were not half the average of any other cable company. He would ask ordinary shareholders not to expect that they were going to run into dividends, for they would soon lose the Martinique subsidy, the Guadeloupe subsidy would also cease in a few years, therefore he would not foster any exaggerated notions about the value of the shares.

In answer to questions he would leave the problem of receiving ordinary dividends to shareholders themselves.

A vote of thanks to the chairman terminated the meeting.

**Kelvinside Electricity Company, Limited.**—This company was incorporated in 1889 to supply electricity for illuminating and other purposes in the district of Kelvinside, the principal residential suburb of Glasgow. At the request of the local authority, and in order to efficiently supply the district, the directors resolved to increase the capital from £10,000 to £50,000, and accordingly the capital has now, by special resolution of the company, been increased to the above-mentioned sum of £50,000, in £1 shares. The unsubscribed capital is now offered for subscription, payable 2s. 6d. on application, 2s. 6d. on allotment, and the balance, as required, in calls not exceeding 5s., at intervals of not less than three months. This is the only company which has powers to supply electricity under the Electric Lighting Acts in that district. According to estimates, the capital outlay for plant required for a full installation of 30,000 glow lamps will amount to £40,000.

**Swan United Electric Company.**—At the meeting of the shareholders, which is to be held on the 25th inst., the directors will recommend a dividend of 10 per cent. for the year ended September 30th.

**An Elmore Copper Company for America.**—A prospectus is announced to be shortly issued of an Elmore copper company for the United States.

**Commercial Cable Company.**—This company has opened a branch office at 4, Charing Cross, S.W.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 7th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £8,979.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (November 6.)	Closing Quotation. (November 13.)	Business done during week ending November 13, 1890.	highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	99 — 102	99 — 102		99½	...
1,549,160	Anglo-American Telegraph, Limited	Stock	49 — 50	49 — 50		48½	...
2,725,420	Do. do. 6 p. c. Preferred	Stock	85 — 86	85 — 86		85½	83½
2,725,420	Do. do. Deferred	Stock	13½ — 13¾	13 — 13½		13½	13
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 11¾	11½ — 11¾		11½	11½ xd & bonus
84,500	Do. do. 5 p. c. Bonds	100	101 — 103	101 — 103		101	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 — 108	104 — 108		108	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 1¾	1½ — 1¾		1½	...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2		1½	...
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104		102	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	½ — ½ xd	½ — ½		½	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5¾	5½ — 5¾		5½	...
16,000	Cuba Telegraph, Limited	10	11½ — 12	11½ — 12		11½	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		17	...
12,981	Direct Spanish Telegraph, Limited	5	3¾ — 4¼	3¾ — 4¼		4	3¾
6,090	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½		8½	...
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10¾ xd	10 — 10½		10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14	13½ — 13½		13½	13½
70,000	Do. do. 6 p. c. Preference	10	14½ — 15¼	14½ — 15¼		15¼	14½
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109		106	...
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	103 — 106	103 — 106		104½	103
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	14 — 14½	13½ — 14½		14½	13½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102		100	...
91,800	{ Do. do. 5 p. c. (Ans. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326 }	{ 100 }	{ 102 — 105 }	{ 102 — 105 }		{ 102 }	{ 102 }
325,200	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400	100	102 — 105	102 — 105		102	...
145,300	{ Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	{ 100 }	{ 101 — 104 }	{ 101 — 104 }		{ 101 }	{ 101 }
198,200	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 — 104	101 — 104		101	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	8 — 8½	7¾ — 8¼		8	7¾
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5¼	4½ — 5¼		4½	4½
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	5 — 5½	4½ — 4¾		5½	4¾
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid) }	{ 2 }	{ 1½ — 2¼ }	{ 1½ — 2¼ }		{ 1½ }	{ 1½ }
20,000	Fowler-Waring Cables, Nos. 301 to 20,000	5	2½ — 3	2½ — 3½		2½	2½
180,227	Globe Telegraph and Trust, Limited	10	9 — 8½	8½ — 9½		8½	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 14¾	14½ — 15		14½	...
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16¼	15½ — 16¼		15½	...
15,900	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104		101½	...
230,000	Do. do. (issue of 1883)	100	104 — 107	104 — 107		105	...
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½		11½	...
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½		11½	...
41,609	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18 — 19		18½	...
200,000	Do. do. 4½ p. c. Deb., 1896	100	100 — 102	100 — 102		100	...
17,000	Indo-European Telegraph, Limited	25	35 — 37 xd	35 — 37		35	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 (£7 pd.)	10	6½ — 7	6½ — 7½		6½	...
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	6½ — 7	6½ — 7½		6½	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6½ — 7½		6½	...
100,000	Do. do. 6 p. c. Debentures	100	105 — 108	105 — 108		105	...
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5 — 5½	5½ — 6		5½	...
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4½ — 4¾	4½ — 4¾		4½	4
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12 — 12½		12	...
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½ — 10½	9½ — 10½		9½	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8 — 8½	8 — 8½		8	...
9,000	Reuter's, Limited	8	8½ — 8¾	8½ — 8¾		8½	...
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	{ 1 }	{ 8 — 8½ }	{ 8 — 8½ }		{ 8 }	{ 8 }
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3 xd	2½ — 3		2½	...
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117		113	...
78,949	Swan United Electric Light, Limited	5	5 — 5½	5 — 5½		5½	...
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45		45	44
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		100	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4		3	...
146,128	Do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 94		90	...
3,200	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½ — 9½	8½ — 9½		8½	...
290,900	Do. do. 5 p. c. Debentures	100	98 — 101	98 — 101		90½	99
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5		4½	...
150,000	Do. do. 8 p. c. Debs, repay. 1902	100	102 — 107	102 — 107		105	104½
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½		11½	11½
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 7	6½ — 6¾		6½	5¾
27,873	Do. do. do. 5 p. c. Deferred	7½	4½ — 5	4½ — 5		4½	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106		103	...
250,000	Do. do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106		103	...
88,321	West India and Panama Telegraph, Limited	10	3 — 3½	3½ — 3¾		3½	3½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 12		11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	14 — 15	14 — 15		14	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125 xd	120 — 127		120	...
175,100	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103		99	...
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 3	2½ — 3		2½	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7¾.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 2½—2¾.—House-to-House Company (£5 paid), 4½—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2¾.—Manchester Edison and Swan Company, £3 (£1 paid) 11/- — 13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2½—¾.—Preference, 4½—4¾.

BANK RATE OF DISCOUNT.—5 per cent. (25th September 1890).

## INDUSTRIALISM.\*

By W. B. ESSON.

(Concluded from page 554.)

But how does this affect the workman himself? Well, generally he works shorter hours than ever he did, and the purchasing power of the wage he receives is higher than ever. Individually, or in combination with others, he is free to bargain with his employer for the price of his labour, and nobody interferes. Yet, that he is far from satisfied with his lot, is a matter of daily observation. That the employer is displeased with his profits is also made manifest. That both fail to adjust their differences amicably is a fact which continues to be emphasised by constantly recurring strikes and lock-outs. In June of this year, for example, there were 79 strikes recorded, in July there were 99, and in August the number rose to 105. Some of these were of considerable magnitude and importance. The dock labourers and seamen headed the list with 16. The cotton trades come next with 15; the building trades follow with 12 and the miners with 9, the remainder being divided among the miscellaneous trades. Since then strikes in the iron and shipbuilding trades have been rife. As I write a strike in the tin-plate trade has just terminated, battalions of troops are held in readiness at Chatham to quell disturbance should the Beckton gas stokers strike, news comes that for the first time in the history of our iron manufacture all the Scotch furnaces, with the exception of those at Carron and Wishaw, are out of blast, the furnacemen having struck work. It must be remembered that each strike or lock-out is a confession of failure on the part of employers' associations or men's unions to adjust their differences in a reasonable spirit. These combinations exist for the purpose of settling labour disputes peaceably. A strike or lock-out is the last resource of either, and when this has taken place employer and employed stand related to each other as do two nations who, after vainly attempting to come to terms in the council chamber or refusing to submit to arbitration, determine to meet in the battle-field. The industrial battle, though generally a bloodless one, is inevitably disastrous, which, ever side gains, and these violent methods of settling disputes can only be regarded as constituting a virulent disease to which the industrial organism in its present stage of development is exceedingly liable. Nor can disease seize on one part of the system without producing, to a greater or less extent, functional derangement throughout the whole. A strike amongst the blast furnacemen, for instance, while it reduces the output of iron, throws upon the market a quantity of coal, which, before the strike, was used in smelting. This will make prices fall, and if the strike were long continued, would probably lead to a reduction of the miners' wages. Again, if the demand for iron keeps up, the price will rise as stocks are exhausted, and the price of manufactures in which iron and steel are employed, will rise accordingly. Owing to the rise, the demand in the shipbuilding and other iron-using industries will fall off, and the wages of those engaged in them may be in turn reduced. Of course I don't say that all these things will inevitably occur. What I mean is that the strike creates forces tending to make them happen, and which, if applied for a sufficiently long period, would doubtless have the result indicated. I use this illustration to show that every branch of industry hangs as it were upon another. Men think they are fighting the capitalist, when they are really fighting the workmen in a different branch of trade as well, and endeavouring to obtain a rise of wages partially at their expense. Emphasising this very point, there comes, while I write, the news that a thousand men are locked out in the engineering works at Newport, owing to a dispute between the smiths and boiler-makers.† As a matter of fact, profits and wages are derived from the same fund, employer and employed alike endeavouring to make the shares they respectively receive as large as possible.

Then outside the region of skilled labour, to which the observations in preceding paragraphs are mostly applicable, is a host of unskilled workman whose condition in many cases is, to say the least, precarious. Towards the Docks and the East-End drift this flotsam and jetsam of labour, and the attempts, successful to some extent, to form the dockers at different ports into a compact combination capable of bargaining for its services *en masse*, will be fresh in your memories. In the organised branches of this labour, however, strike has followed strike for the past twelve months in rapid succession. The Southampton riots are an affair of a month ago, and to-day steamers are lying in the London Docks with grain cargoes which corn porters refuse to unload, notwithstanding the advice of their union leaders to the contrary. The right of men to strike is admitted. The principle of free labour is, that if a man is dissatisfied he is at liberty to leave work and make a better bargain for his labour elsewhere. But while admitting the right, it is quite another question whether this right is being exercised to advantage or disadvantage. It seems here that the men have got quite beyond the control of the Union officers. Intoxicated with success they seem to think that there are no extremes to which they may not go. They are like an army which, in the triumph of

victory, exhibits insubordination, becomes disorganised and falls an easy prey to an enemy on the watch for advantages.

That strikes are a blot on Industrialism is admitted by all, nor is evidence wanting to show that they are conducted frequently in that spirit of militancy which is inherited from more barbarous ages. Coercion and intimidation are frequently resorted to. Rioting is common, and the strikers when arguing with the recalcitrant "blackleg" are not averse to occasionally emphasising the chief points by the aid of sticks or crowbars. In fact, gentlemen, we have in the conduct of a modern strike the old aggression appearing, we have the persecution, the intolerance and the oppression bred in our bones made manifest. We have all the evil of the human nature of our time revealed, which only the discipline of centuries to come can thoroughly eradicate.

But outside organisation of any kind is a shiftless throng of humanity living in rookeries, degraded, ill-clad, and yore fed. It is almost impossible for us to conceive how these creatures exist. As you know, competition is blamed for much of the evil in the East-End, and a Sweating Commission investigated the conditions under which the poor live but a short time ago. After collecting information regarding their lives from all sources, the Commission issued a bulky report, which is practically bare of suggestion. It is, in short, an acknowledgment that for the precarious wages and the state of misery revealed, the legislature can offer no remedy. Irremediable though it may be, however, it is still a blot on the industrial system.

But trade disputes, inadequate wages and poverty, are not the only blots observable. Writing of Glasgow, fifty years ago, a writer remarked that every Saturday and for the most part of Sunday, ten or twenty thousand workmen were more or less intoxicated, every farthing which could be spared being too often converted into ardent spirits. "The same individuals, who, a year before, were reduced to pawn their last shreds of furniture to procure subsistence, recklessly threw away the surplus earnings of more prosperous times in the lowest debauchery. The warnings of religion, the dictates of prudence, the means of instruction, the lessons of adversity, are alike overwhelmed by the passion for momentary gratification."\* That was written in 1840, but it is fairly true to-day. Anyone who studies closely the habits of the labouring classes in our large towns, cannot fail to be struck with the truth of Mr. Alison's observations. Improvidence, extravagance, and intemperance, are the besetting sins of the British workman. "Very few of them lay by in anticipation of times when work is slack; and the general testimony is that higher wages commonly result only in more extravagant living or in drinking to greater excess." From personal experience of workmen, I should say that in the large towns of England there is spent on an average from 15 to 20 per cent. of the earnings on beer and tobacco. Providence plays but an unimportant part in their lives. They listen to the voice of instinct and follow the promptings of unregulated desire, but for the most part lack that power of self-denial which should enable them to sacrifice present enjoyment in order to obtain future benefit. I speak of them now as a class, but that there are many exceptions to this general rule goes without saying. Nevertheless, it will be observed that the labourers' grievances are largely of their own creation. Though they talk much of co-operation, they continue to pour the possible capital down their throats or blow it in the air.

Here then is the position of things. The units composing the industrial community are exceedingly imperfect, consequently the present industrial system works imperfectly, production being hampered by continual bickerings, not only between employer and employed, but between the various sections of the latter as well. The earnings of industry after paying rent and taxes are divided into two parts, one payable to the capitalist for the loan of his capital, interest, the remainder constituting a wages-and-profits fund, which is divided between the managers and the workmen. So far as can be made out, it is the contention of the workman that the latter fund is unfairly divided, and in one or two words we may examine the conditions which regulate the division. First, however, it is necessary that the amount payable as interest be confused in no way with the amount devisable as earnings of management and earnings of labour among the producers. Though the same individual may be capitalist and manager, as often happens, the sums payable as interest and as earnings of management are to be considered quite separately. The amount due to interest is represented by the sum which the employer would get for the use of his capital if it were lent to a business man who managed a concern of the same kind as his own and having similar risks, is determined, in fact, by the market price of capital. This, as everyone knows, depends upon the demand for the use of money and the risk attending the lending of it. A Corporation whose security is excellent, can borrow readily at from 3 to 3½ per cent. But where there are various risks involved, as in most trading concerns, the borrowers have to raise money on mortgage debentures at 4½ to 5 per cent. Let it be understood that the capitalist has not fixed the amount of interest. That has been fixed by the competition for the aid of capital and the conditions under which it is lent. If the demand for the use of money is great, interest is forced up; if it gets less, interest falls. I conceive that the workman's objections are not to the interest the employer as a capitalist receives, but to the profits or, more properly, "earnings of management" which he takes from the wages-and-profits fund. Indeed, the workman by placing his savings in the bank may himself become a

\* Presidential Address delivered to the Old Students' Association of the City and Guilds of London Institute at Finsbury College, November 6th, 1890.

† October 5th.

‡ October 6th.

\* Mr. Alison on "Population," Vol. I., page 290.

capitalist to the extent of his means and get paid for the use of his money.

The amount due to interest being deducted then, the wages-and-profits fund remains to be divided amongst the producers. You are no doubt familiar with the saying that the amount of wages received by any particular section of the community is regulated by the supply of, and demand for, their particular kind of labour. But that there are secondary forces coming into action which, in conjunction with supply and demand, are beginning to exercise an important influence on the rate of wages must be apparent to all who have watched recent labour movements. "In an industrial conflict," said Prof. Marshall recently, "each side cares for the opinion of the public at large, but especially for that of those whose sympathy they are most likely to get; in the South Wales strike, for instance, the railway companies were specially anxious about the good opinion of the shippers and the engine drivers about that of the colliers."\* Thus we see that in addition to the influence of supply and demand the influence of public opinion is being brought to bear on questions relating to the adjustment of wages or to the distribution, if I might better put it, of the nett industrial returns. Supply and demand are, however, the great regulators, and upon these mainly the adjustment of wages depends. The capitalist is outside this adjustment. It is effected by competition among the various sections of workers for different kinds of labour; and the higher wages offered to any particular branch when the labourers become scarce in it form the inducement for others to come in, thus increasing the supply, and tending to bring the wages down to their normal level. Managers and business men are not exempt from the universal competition. If business power is scarce a proportionally larger amount is paid for management out of the wages and profits fund, and *ceteris paribus* less remains for the time being for division amongst other workers; if business power is plentiful, proportionally less is paid, and the workers temporarily benefit. If the employer is capitalist and manager at the same time the relation still holds good. True, he may pocket an apparently large sum as earnings of management, but on the other hand his enterprise, energy, ability and fertility of resource have to be paid for.

It is a common saying that a large return means a great risk, and in the case of businesses making large profits, the employer's share may very often be regarded either as the reward of genius and foresight, or as the higher interest he obtains for his capital under the exceptional risk of losing it. Competition between manufacturers in an ordinary way, however, is constantly tending to reduce earnings of management, and in bad times an employer, who is manager and capitalist as well, has very often to endure all the trouble and worry of managing his business for nothing, gaining, in the end, merely a bare interest for his money, such as could be obtained without trouble by lending it to someone else. In a joint stock concern the business is conducted by a manager and board of directors, who both receive wages of management, the capital being furnished by the shareholders. The latter receive a return as interest, and if this rises above the market rate, there are forces applied at once to bring it down to the normal in the form of new companies starting in the same business and entering into competition. What I wish to point out most clearly is that there is for each kind of labour a normal wage value, determined by the proportion which the wages in different employments bear, in order that a supply of workers in each may be forthcoming to meet the demand. Also the competition amongst the different classes, or, in other words, supply and demand, constitute the chief forces which tend to maintain wages at this normal value.

The various combinations of employers and employed have attempted to modify the relation between the wages of different labourers, but whether such combinations can effect, under present arrangements, any considerable change of a permanent character, is open to doubt. It seems to me that "corners" in labour, like corners in raw materials, are very likely to defeat their own ends, and that combinations which seek to obtain more than their proper share from the wages-and-profits fund, are unlikely to meet with other than that temporary success which adjusts their wages again to their normal level. But the present condition of industry is transitory, and only suited to the times. It represents a stage in the growth of Industrialism, and as fast as human nature changes to make a better state of things possible, just so fast will a better state be developed. "It is quite possible," as Mr. Spencer says, "to hold that when instead of devouring their captured enemies, men made slaves of them, the change was a step in advance; and to hold that this slavery, though absolutely bad, was relatively good, was the best thing practicable for the time being. It is quite possible, also, to hold that when slavery gave place to a serfdom under which certain personal rights were recognised, the new arrangement, though in the abstract an unequitable one, was more equitable than the old, and constituted as great an amelioration as men's natures then permitted. It is quite possible to hold that when, instead of serfs there came freemen working for wages, but held as a class in extreme subordination, this modified relation of employers and employed, though bad, was as good a one as could then be established." And so it may be held that at the present time, though the form of industrial government entails serious evils, those evils, much less than the evils of the past times, are as small as the

average human nature allows—are not due to any special injustice of the employing class, and can be remedied only as fast as men in general advance."\* And there are, here and there, signs of a higher industrial organisation. Co-operation proposed long ago a system, under which the workers are themselves the capitalists, is making progress. Profit sharing, a system which, after paying fixed wages and fixed earnings of management, allows of another distribution, *pro rata*, from the wages-and-profits fund, is, in several instances, being adopted. Only slowly, however, are these changes occurring, and several schemes had to be reported by the Labour Association in August as having "been temporarily abandoned, owing to the antagonistic attitude of the several trades unions." A most hopeful feature of this report, however, was that the question as regards the "workers sharing in losses as well as profits, had received a very practical answer from the workers of Messrs. Thomson and Sons, of Huddersfield, whose business was based on industrial partnership lines. Last year it was found impossible to pay any interest on share capital, and the workers resolved to pay interest themselves out of their own wages."† That spirit which freely recognises the claims of all, the sentiment of justice, mutual trust and mutual forbearance, are amongst the factors which will in time produce the industrial reformation.

In the course of this address I have talked of the industrial organism, and the term is not as might be supposed a mere figure of speech. In its gradual development from a simple to a complex form, in its continued differentiation of functions, in its ever-growing mutual dependence of parts, and in its increasing co-operation of members Industrialism manifests all the changes which take place in the course of organic evolution from the lowest to the highest type. And in the nature of man—the social unit—must be sought the cause of this gradual advancement. As amongst lower animals the increase of numbers and the struggle for subsistence has been the means of developing those special features exhibited by different species, so among men, the redundancy of numbers and the striving of each to gratify his desires have been developing a skill, intelligence, and self-control, which will in time lift him from savagery to the highest civilisation. That the present state of society is but transient has been already pointed out. It is the product of past and present, and represents the progress of evolution up to date. It has to be perceived that society is an aggregate of men, that it must therefore manifest in its institutions all the defects possessed by the units of which it is made up. That it is faulty in many particulars is apparent, but that it is the best—nay, that it is the only state possible for the time being, must, at the same time, be admitted. Only as fast as men, the units, advance, and as human nature improves, can a better state of society, the aggregate, arise.

People are loth to believe that institutions can only evolve, are impossible of manufacture. It is sometimes amusing to read the various manifestos of State socialists, ready with their cut-and-dried schemes to regenerate Industrialism, and professing that were their plans adopted, the traits which have characterised humanity through countless ages would forthwith disappear. And yet, perhaps, the published utterances of socialist leaders constitute the best proof that they are unfitted for a better condition of things. Men who talk of confiscating property without the slightest regard for the claims of the owners, manifest by their language their unfitness for a condition of society which implies a fuller recognition of men's rights. But some are foolish enough to believe that the passing of this or that Act would regenerate humanity, and that the men who show themselves to be guided by the instincts of robbers, are those who are to be instrumental in bringing about an industrial millenium. They have history to teach them, but they will not be taught. In olden times, the government imposed endless restrictions on industry, but one by one they have been removed, because found in time to be a mistake and discovered to intensify the evil they pretended to remedy. That the removal of these restrictions has been of immense service to industry most thinking men will admit. Nevertheless, in our day, a school has arisen which demands State interference of such a character that the restrictions of former times pale by comparison.‡ One can scarcely take up a daily paper which does not contain some attack on a State department for the perfunctory performance of its duties, and yet, notwithstanding this daily accumulating evidence, it is implicitly believed that for all evils to disappear, society has merely to be transformed into a huge government office.

That Socialism—inasmuch as the term implies complete adaptation to the social state—is the ultimate goal of society has been implied, but that this can be furthered by governments which exist because of the imperfections of humanity, is doubtful. "Perpetually, governments have thwarted and deranged the growth, but have in no way furthered it; save by partially discharging their proper function and maintaining social order. It is not to the State," quoting Spencer, "that we owe the multitudinous useful inventions from the spade to the telephone; it was not the State which made possible extended navigation by a developed astronomy; it was not the State which made the discoveries in physics, chemistry and the rest which guide modern manufacturers; it was not the State which devised machinery for producing fabrics of every kind, for transferring men and things from place to place, and for ministering in a thousand ways to our comforts. The world-wide transactions con-

\* The British Association 1890 Meeting. Presidential Address to Section F.

\* "The Study of Sociology," p. 253.

† See Report of the Labour Association for 1890.

‡ See The Radical Programme; Chapman and Hall.

ducted in merchants' offices, the rush of traffic filling our streets, the retail distributing system which brings everything within easy reach and delivers the necessities of daily life at our doors, are not of governmental origin. All these are the results of the spontaneous activities of citizens separate or grouped; "are, in fact, the results due to competition and to each one endeavouring to satisfy his own individual desires. So much has competition done; but those who have to do with Government departments know well that they are the last places in which enterprise or zeal, or even activity, is to be looked for. It will not do. The first requirement of progress is freedom of action. That everyone shall be at liberty to satisfy his desires in his own way, provided the equal liberty of others is not infringed, is the all-essential condition, for only in the endeavour to obtain their satisfactions have the intelligence and culture of modern times been developed.

I have referred to the improvidence of the working classes, but the influence which bad legislation has had in forming their improvident habits is generally ignored. As a matter of fact, they have been disciplined in improvidence for centuries, the punishment which extravagance should bring having been averted by the operation of the Poor Laws. Men have been taught that if they lack the foresight or self-denial entailed by preparation for old age, it is the duty of the State to make requisite provision for them, a premium having been thus put upon idleness, improvidence, drunkenness and licentiousness by taxing the virtuous and independent in order that the vicious might lead easy lives and multiply faster. Our State organised charity is a scandal to civilisation, but State Socialism, mark you, is but State charity on a gigantic scale. "It is a fact apparent to every thoughtful man," says a clever writer, "that the larger portion of the misery which constitutes our social question arises from idleness, gluttony, waste, profligacy, betting and dissipation. Reliance on industry, self-respect and energy, does not enter into the socialistic propaganda. In some vague way the poor man who is a voluptuous prodigal under the present order of things is to become wise and virtuous when property is held in common. But this is loose thinking which deceives no one who can think intelligently. He that is filthy will be filthy still, and he that is unjust will remain unjust in the absence of a moral change within."† All legislative attempts to equalise mankind must be futile, and not only futile, but mischievous, as their immediate effect, apart from evils more remote, is to increase the number of undeserving at the expense of the deserving. The human species obeys the laws of life by which all species are governed, and one of the fundamental generalisations of biology is, that fertility is determined by environment; that the rate of multiplication is always adapted to the conditions of existence. For every species there is a normal rate of increase, and if from any cause the relation existing between the organism and the environment becomes modified, a corresponding change in fertility results. Other things remaining the same if the conditions of life are made easier for a species, its rate of propagation increases, and from this universal law there is no escape. If the State, by relieving the citizen of responsibilities, voluntarily but imprudently undertaken, makes the conditions of his life less severe, self-reliance is displaced, self-respect is diminished and self-restraint is discounted. Relieved to an extent of the necessity for individual exertion, the rate of multiplication will rise above the normal, and only fall to it again if from increase of numbers the struggle for existence be raised to its former severity. The mean result of this interference on the part of the State is permanent increase of numbers in a lower grade of life, and permanent diminution in a higher, the struggle for existence being at the same time diminished as regards the former, and increased as regards the latter temporarily or permanently, as the case may be. Economists are fond of telling us that the "Standard of Comfort" of the people must be raised if the growth of population is to be checked. In the nature of things this means increased self-denial and a fuller recognition of responsibilities. It means an ideal which can only be realised by individual effort, a something to be by-and-bye gained by sacrifice now. The standard of comfort can be raised only by increased individuation. There is no other way. However implanted the incentive to rise must act from within and only by each progressive movement entailing more and more individuation, is the energy available for genesis diminished. The gospel of State Socialism is mere rubbish. To employ Mr. Arnold White's pithy summary, it is a gospel which equalises "genius and stupidity, industry and indolence, waste and thrift." It constitutes a removal of the forces which have operated from the dawn of civilisation till now to adapt men to the social condition. It comprises an unfitting process under which every deserving member of society gets less than the share he merits, in order that every undeserving member may get more.

From these remarks, it must not be thought that I am justifying the present state of Industrialism; far from it. My object has been simply to show that it is the best the average human nature of the time will permit of. It is a fact which must be ever kept in mind that human nature cannot be revolutionised by Acts of Parliament, nor can the evils which result from the average defects of humanity be eradicated by State measures. It is equally important to remember that human nature changes slowly, though it is utterly fallacious to assume, as some do, that

it changes not at all. It is the function of the Government to protect the citizen from foreign foe and civil aggressor, to enforce justice, to remove hindrances, and permit society, with fullest freedom, to work out its own salvation. If the present were the end, economists might well close their books and admit, with Carlyle, that their science were somewhat dismal. But to those who realise that the present is but a stage in development, and that the process which has already lifted us from savagery to semi-civilisation must continue till the adaptation is complete; to those who believe that in time the traits of a bye-gone savagery will disappear, the future of humanity is full of hope. Nor are signs wanting that we are making progress. Notwithstanding the various labour battles being fought around us, I think there is, amongst the more enlightened, evidences of fuller co-operation between the various sections of industry. Both masters and men are becoming a little less selfish, and are getting to trust each other more fully. Aggressiveness on each side is diminishing, and there is distinct indication of growing sympathy between them. As a result, a great development of profit-sharing arrangements, industrial partnerships and other schemes in which active co-operation is requisite, may be looked for in the near future. In these the hopeful see the beginning of the end.

But by no legislative legerdemain is the final goal to be reached, and it is through the purgatory of competition that we must pass to an industrial heaven. Remember the social state was forced on man by redundancy of numbers. "From the beginning, pressure of population has been the proximate cause of progress. It produced the original diffusion of the race. It compelled men to abandon predatory habits, and take to agriculture. It led to the clearing of the earth's surface. It forced men into the social state, made social organisation inevitable, and has developed the social sentiments. It has stimulated to progressive improvements in production, and to increased skill and intelligence. It is daily thrusting us into closer contacts and more mutually-dependent relationships."\* And with each advance in intelligence, with each demand on the increased individuation rendered imperative by the struggle for existence, there goes the inevitable diminution of fertility. "After having caused, as it ultimately must, the due peopling of the globe and the raising of all its habitable parts to the highest culture; after having brought all processes for the satisfaction of human wants to perfection; after having at the same time developed the intellect into complete competency for its work, and the feelings into complete fitness for social life; after having done all this, the pressure of population, as it gradually finishes its work, must gradually bring itself to an end."†

And here, based on history and on science, is foreshadowed a Utopia, in the presence of which even dreamers may well stand wonderstruck. From Sir Thomas More to Edward Bellamy, from Fourier to Grant Allen, the thinkers who have been struck with the misery of mankind have each in turn manufactured a system in accordance with their ideas of what ought to be. And having manufactured a system, they manufactured the human units to suit it. But they altogether ignore the power of the forces which have secured the partial adaptation to work out the adjustment to the end. That the harmony is far from complete is apparent; that man has instincts unfitted for social life is undeniable; but it is none the less sure that the process of adaptation to environment is gradually eradicating those hurtful instincts, and bringing into being emotions corresponding to complete harmony between faculties and surroundings. Nor will work be regarded in any sense a burden when this time arrives. Only pleasure is experienced by the exercise of faculties perfectly adjusted to requirements, and when the adjustment is complete, the efforts requisite for existence will constitute but a pleasurable activity. A time must be contemplated when the overflow of capital from rich countries into uncultivated or ill-cultivated regions of the earth must cease, and when for new works of vast magnitude its aid will be no longer required. Due to this lessened demand, the rate of interest will gradually fall, and the inducements to save large sums for one's personal benefit will diminish. The desire to possess great wealth arises because of the power it gives rather than the happiness it secures; but the desire for power, born of aggression, must eventually disappear with the growth of altruistic feelings. If Mr. Ravenstein's figures\* are to be trusted, barely two centuries will elapse before the globe is peopled with the six thousand millions it can support, and the condition attained under which the final adjustment of man to his environment must be effected. When this latter is accomplished, complete harmony will reign, and so we arrive at a Socialism, complete and all satisfying, achieved by forces older than humanity itself, and worked out by that Evolution which clasps the Universe in its all-powerful embrace.

**Bromley and the Electric Light.**—The Bromley Local Board has decided to make application to the Board of Trade for a provisional order to construct works, and to produce, store, supply and sell electricity for light, motive power, and all public and private purposes within its area.

\* "The Man v. The State," page 63.

† Mr. Arnold White on "Socialism" in the *Weekly Times* and *Echo*, September 28th, 1890.

\* Herbert Spencer's "Principles of Biology," Vol. II., p. 507.

† See Mr. Ravenstein's speech, Conference of Statistical and Geographical Sections, British Association, 1890.

### THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 568.)

Suppose we are working with the magnetisation of our iron pushed to about 16,000 lines to the square centimetre (i.e., about 150 lbs. per square inch, traction), requiring a magnetising force of about  $H = 50$ ; then, referring to the table, we see that each joint across the iron offers as much reluctance as would an air gap 0.0005 of an inch in thickness, or adds as much reluctance as if an additional layer of iron about  $\frac{1}{80}$ th of an inch thick had been added. With small magnetising forces the effect of having a cut across the iron with a good surface on it is about the same as though you had introduced a layer of air  $\frac{1}{80}$ th of an inch thick, or as though you had added to the iron circuit about 1 inch of extra length. With large magnetising forces, however, this disappears, probably because of the attraction of the two surfaces across that cut. The stress in the magnetic circuit, with high magnetic forces running up to 15,000 or 20,000 lines to the square centimetre, will of itself put on a pressure of 130 to 230 lbs. to the square inch, and so these resistances are considerably reduced; they come down, in fact, to about  $\frac{1}{30}$ th of their initial value. When Ewing specially applied compressing forces, which were as large as 670 lbs. to the square inch, which would of themselves ordinarily, in a continuous piece of iron, have diminished the magnetisability, he found the diminution of the magnetisability of iron itself was nearly compensated for by the better conduction of the cut surface. The old surface, cut and compressed in that way, closes as it were magnetically up—does not act like a cut at all; but at the same time you lose just as much as you gain, because the iron itself becomes less magnetisable.

The above results of Ewing are further represented by the curves of magnetisation drawn in fig. 48. When the faces of a cut were carefully surfaced up to true planes, the disadvantageous effect of the cut was reduced considerably, and, under the application of a heavy external pressure, almost vanished.

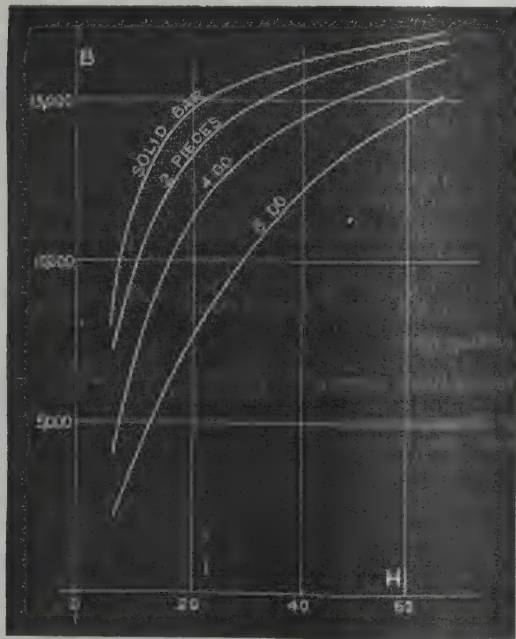


FIG. 48.—EWING'S CURVES FOR EFFECT OF JOINTS.

I have several times referred to experimental results obtained in past years, principally by German and French workers, buried in obscurity in the pages of foreign scientific journals. Too often, indeed, the scattered papers of the German physicists are rendered worthless or unintelligible by reason of the omission of some of the data of the experiments. They give no measurements perhaps of their currents, or they used an uncalibrated galvanometer, or they do not say how many windings they were using in their coils; or perhaps they give their results in some obsolete phraseology. They are extremely addicted to informing you about the "magnetic moments" of their magnets. Now the magnetic moment of an electro-magnet is the one thing that one never wants to know. Indeed, the magnetic moment of a magnet of any kind is a useless piece of information, except in the case of bar magnets of hard steel that are to be used in the determination of the horizontal component of the earth's magnetic force. What one does want to know about an electro-magnet is the number of magnetic lines flowing through its circuit, and this the older researches rarely afford the means of ascertaining. Nevertheless, there are some investigations worthy of study to which time will now only permit

\* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

me very briefly to allude. These are the researches of Dub on the effect of thickness of armatures, and those of Nicklès and of Du Moncel on the lengths of armatures. Also those of Nicklès on the effect of width between the two limbs of the horse-shoe electro-magnet.

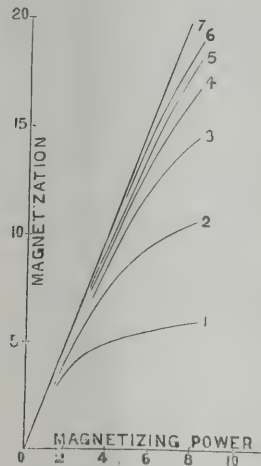


FIG. 49.—VON FEILITZSCH'S CURVES OF MAGNETISATION OF TUBES.

I can only now describe some experiments of Von Feilitzsch upon the vexed question of tubular cores, a matter touched by Sturgeon; Pfaff, Joule, Nicklès, and later by Du Moncel. To examine the question whether the inner part of the iron really helps to carry the magnetism, Von Feilitzsch prepared a set of thin iron tubes which could slide inside one another. They were all 11 centimetres long, and their peripheries varied from 6.12 centimetres to 9.7 centimetres. They could be pushed within a magnetising spiral to which either small or large currents could be applied, and their effect in deflecting a magnetic needle was noted, and balanced by means of a compensating steel magnet, from the position of which the forces were reckoned and the magnetic moments calculated out. As the tubes were of equal lengths, the magnetisation is approximately proportional to the magnetic moment. The outermost tube was first placed in the spiral, and a set of observations made; then the tube of next smaller size was slipped into it and another set of observations made; then a third tube was slipped in until the whole of the seven were in use. Owing to the presence of the outer tube in all the experiments, the reluctance of the air return paths was alike in every case. The curves given in Fig. 49 indicate the results. The lowest curve is that corresponding to the use of the first tube alone. Its form, bending over and becoming nearly horizontal, indicates that with large magnetising power it became nearly saturated. The second curve corresponds to the use of the first tube with the second within it. With greater section of iron saturation sets in at a later stage. Each successive tube adds to the capacity for carrying magnetic lines, the beginning of saturation being scarcely perceptible, even with the highest magnetising power, when all seven tubes were used. All the curves have the same initial slope. This indicates that with small magnetising forces, and when even the least quantity of iron was present, when the iron was far from saturation, the main resistance to magnetisation was that of the air paths, and it was the same whether the total section of iron in use was large or small.

I must leave till my next lecture the rules relating to the determination of the windings of copper wire on the cores.

#### APPENDIX TO LECTURE II.

##### CALCULATION OF EXCITATION, LEAKAGE, &C.

###### Symbols used.

- $N$  = whole number of magnetic lines (C.G.S., definition of magnetic lines, being 1 line per sq. centim. to represent intensity of a magnetic field, such that there is 1 dyne on unit magnetic pole) that pass through the magnetic circuit. Also called the *magnetic flux*.
- $B$  = the number of magnetic lines per square centimetre, in the iron; also called the *induction*, or the internal magnetisation.
- $B_{\text{iron}}$  = the number of magnetic lines per square inch in the iron.
- $H$  = the magnetic force or intensity of the magnetic field, in terms of the number of magnetic lines to the square centimetre that there would be in air.
- $H_{\text{air}}$  = the magnetic force, in terms of the number of magnetic lines that there would be to the square inch, in air.
- $\mu$  = the *permeability* of the iron, &c.; that is its magnetic conductivity or multiplying power for magnetic lines.
- $A$  = area of cross section, in square centimetres.
- $A''$  = area of cross section, in square inches.
- $l$  = length, in centimetres.
- $l''$  = length, in inches.
- $s$  = number of spirals or turns in the magnetising coil.

$i$  = electric current, expressed in amperes.  
 $v$  = coefficient of allowance for leakage; being the ratio of the whole magnetic flux to that part of it which is usefully applied. (It is always greater than unity.)

#### Relations of Units.

1 inch = 2.54 centimetres;  
 1 centimetre = 0.3937 inch.  
 1 square inch = 6.45 square centimetres;  
 1 square centimetre = 0.1550 square inch.  
 1 cubic inch = 16.39 cubic centimetres;  
 1 cubic centimetre = 0.0610 cubic inch.

To calculate the value of  $B$  or of  $B_{\mu}$  from the Traction.

If  $P$  denote the pull, and  $A$  the area over which it is exerted, the following formula (derived from Maxwell's law, see p. 899) may be used:—

$$B = 4,965 \sqrt{\frac{P \text{ kilos.}}{A \text{ sq. cm.}}};$$

$$B = 1,316.6 \sqrt{\frac{P \text{ lbs.}}{A \text{ sq. in.}}}; \text{ or}$$

$$B_{\mu} = 8,494 \sqrt{\frac{P \text{ lbs.}}{A \text{ sq. in.}}}.$$

To calculate the requisite cross section of Iron for a given Traction.

Reference to page 896 will show that it is not expedient to attempt to employ tractive forces exceeding 150 lbs. per square inch in magnets whose cores are of soft wrought iron, or exceeding 28 lbs. per square inch in cast iron. Dividing the given load that is to be sustained by the electro-magnet by one or other of these numbers, gives the corresponding requisite sectional area of wrought or cast iron respectively.

To calculate the Permeability from  $B$  or from  $B_{\mu}$ .

This can only be satisfactorily done by referring to a numerical table (such as Table II. or IV.), or to graphic curves, such as fig. 18, in which are set down the result of measurements made on actual samples of iron of the quality that is to be used. The values of  $\mu$  for the two specimens of iron to which Table II. refers may be approximately calculated as follows:—

$$\text{For annealed wrought iron, } \mu = \frac{17,000 - B}{3.5};$$

$$\text{For grey cast iron, } \mu = \frac{7,000 - B}{3.2}.$$

These formulæ must not be used for the wrought iron for tractions that are less than 28 lbs. per square inch, nor for cast iron for tractions less than  $2\frac{1}{4}$  lbs. per square inch.

To calculate the Total Magnetic Flux which a core of given sectional area can conveniently carry.

It has been shown that it is not expedient to push the magnetisation of wrought iron beyond 100,000 lines to the square inch, nor that of cast iron beyond 42,000. These are the highest values that ought to be assumed in designing electro-magnets. The total magnetic flux is calculated by multiplying the figure thus assumed by the number of square inches of sectional area.

To calculate the Magnetising Power requisite to force a given number of Magnetic Lines through a definite Magnetic Reluctance.

Multiply the number which represents the magnetic reluctance by the total number of magnetic lines that are to be forced through it. The product will be the amount of magneto-motive force. If the magnetic reluctance has been expressed on the basis of centimetre measurements, the magneto-motive force, calculated as above, will need to be divided by 1.2566 (i.e., by  $\frac{4\pi}{10}$ ) to give the number of ampère turns of requisite magnetising power. If, however, the magnetic reluctance has been expressed in the units explained below, based upon inch measures, the magnetising power, calculated by the rule given above, will already be expressed directly in ampère turns.

TO CALCULATE THE MAGNETIC RELUCTANCE OF AN IRON CORE.

(a.) If dimensions are given in centimetres.—Magnetic reluctance being directly proportional to length, and inversely proportional to sectional area and to permeability, the following is the formula:—

$$\text{Magnetic reluctance} = \frac{l}{A\mu};$$

but the value of  $\mu$  cannot be inserted until one knows how great  $B$  is going to be; when reference to Table II. gives  $\mu$ .

(b.) If dimensions are given in inches.—In this case we can apply a numerical co-efficient, which takes into account the change of units (2.54), and also, at the same time, includes the operation of dividing the magneto-motive force by  $\frac{4}{10}$ ths of  $\pi$  (= 1.2566) to reduce it to ampère turns. So the rule becomes

$$\text{Magnetic reluctance} = \frac{l''}{A''\mu} \times 0.3132.$$

*Example.*—Find the magnetic reluctance from end to end of a bar of wrought iron 10 inches long, with a cross section of 4 square inches, on the supposition that the magnetic flux through it will amount to 440,000.

To calculate the Total Magnetic Reluctance of a Magnetic Circuit.

This is done by calculating the magnetic reluctances of the separate parts, and adding them together. Account must, however, be taken of leakage; for when the flux divides, part going through an armature, part through a leakage path, the law of shunts comes in, and the nett reluctance of the joint paths is the reciprocal of the sum of their reciprocals. In the simplest case the magnetic circuit consists of 3 parts (1) armature, (2) air in the two gaps, (3) core of the magnet. These three reluctances may be separately written, as in the Table in next column.

If the iron used in armature and core is of the same quality, and magnetised up to the same degree of saturation,  $\mu_1$  and  $\mu_3$  will be alike. For the air-gaps  $\mu = 1$ , and therefore is not written in.

If there were no leakage, the total reluctance would simply be the sum of these three terms. But when there is leakage, the total reluctance is reduced.

	For centimetre measure.	For inch measure.
1. Armature ...	$\frac{l_1}{A_1 \mu_1}$	$\frac{l''_1}{A''_1 \mu_1} \times 0.3132$
2. The Gaps ...	$2 \frac{l_2}{A_2}$	$2 \frac{l''_2}{A''_2} \times 0.3132$
3. Magnet Core..	$\frac{l_3}{A_3 \mu_3}$	$\frac{l''_3}{A''_3 \mu_3} \times 0.3132$

To calculate the ampère-turns of Magnetising Power requisite to force the desired Magnetic Flux through the reluctances of the Magnetic Circuit.

(a.) If dimensions are given in centimetres the rule is:—

Ampère-turns = the magnetic flux, multiplied by the magnetic reluctance of the circuit, divided by  $\frac{4}{10}$ ths of  $\pi$  (= 1.2566).

Or, in detail, the three separate amounts of ampère-turns required for three principal magnetic reluctances are explained as follows:—

$$\text{Ampère-turns required to drive } N \text{ lines } \left\{ \begin{array}{l} \text{through iron of armature ...} \end{array} \right\} = N \times \frac{l_1}{A_1 \mu_1} \div \frac{4\pi}{10},$$

$$\text{Ampère-turns required to drive } N \text{ lines } \left\{ \begin{array}{l} \text{through the two gaps ...} \end{array} \right\} = N \times \frac{2l_2}{A_2} \div \frac{4\pi}{10},$$

$$\text{Ampère-turns required to drive } vN \text{ lines } \left\{ \begin{array}{l} \text{through the iron of magnet core} \end{array} \right\} = vN \times \frac{l_3}{A_3 \mu_3} \div \frac{4\pi}{10},$$

And, adding up:—

$$\text{Total ampère-turns required} = \frac{10}{4\pi} N \left\{ \frac{l_1}{A_1 \mu_1} + \frac{2l_2}{A_2} + \frac{vl_3}{A_3 \mu_3} \right\},$$

(b.) If dimensions are given in inches, the rule is:—Ampère-turns = magnetic flux multiplied by the magnetic reluctance of the circuit. Or, in detail:—

$$\text{Ampère-turns required to drive } N \text{ lines } \left\{ \begin{array}{l} \text{through iron of armature ...} \end{array} \right\} = N \times \frac{l''_1}{A''_1 \mu_1} \times 0.3132,$$

$$\text{Ampère-turns required to drive } N \text{ lines } \left\{ \begin{array}{l} \text{through two gaps ...} \end{array} \right\} = N \times \frac{2l''_2}{A''_2} \times 0.3132,$$

$$\text{Ampère-turns required to drive } vN \text{ lines } \left\{ \begin{array}{l} \text{through iron core of magnet ...} \end{array} \right\} = vN \times \frac{l''_3}{A''_3 \mu_3} \times 0.3132;$$

And, adding up:—

$$\text{Total ampère turns required} = 0.3132 N \left\{ \frac{l''_1}{A''_1 \mu_1} + \frac{2l''_2}{A''_2} + \frac{vl''_3}{A''_3 \mu_3} \right\}.$$

It will be noted that here  $v$ , the coefficient of allowance for leakage, has been introduced. This has to be calculated as shown later. In the meantime it may be pointed out that, in designing electro-magnets for any case where  $v$  is approximately known beforehand, the calculation may be simplified by taking the sectional area of the magnet core greater than that of the armature in the same proportion. For example, if it were known that the waste lines that leak were going to be equal in number to those that are usefully employed in the armature (here  $v = 2$ ), the iron of the cross might be made of double the section of that of the armature. In this case  $\mu_3$  will approximately equal  $\mu_1$ .

To calculate the Coefficient of Allowance for Leakage,  $v$ .

$v$  = total magnetic flux generated in magnet core + useful magnetic flux through armature. The respective useful and waste magnetic fluxes are proportional to the permeances along their respective paths. Permeance, or magnetic conductance, is the reciprocal of the reluctance, or magnetic resistance. Call useful permeance through armature and gaps  $u$ ; and the waste permeance in the stray field  $w$ ; then

$$v = \frac{u + w}{u}$$

*w* may be estimated by the Table VIII. given on p. 567 (ELEC. REV., November 7th), or other leakage rules, but should be divided by 2 as the average difference of magnetic potential over the leakage surface is only about half that at the end of the poles.

#### RULES FOR ESTIMATING MAGNETIC LEAKAGE.

(I. to III. Adapted from Prof. Forbes's rules.)

*Prop. I.* Permeance between two parallel areas facing one another.—Let areas be  $A_1''$  and  $A_2''$  square inches, and distance apart  $d''$  inches, then:—

$$\text{Permeance} = 3.193 \times \frac{1}{2} (A_1'' + A_2'') \div d''.$$

*Prop. II.* Permeance between two equal adjacent rectangular areas lying in one plane.—Assuming lines of flow to be semicircles, and that distances  $d_1''$  and  $d_2''$  between their nearest and furthest edges respectively are given, also  $a''$  their width along the parallel edge:—

$$\text{Permeance} = 2.274 \times a'' \times \log_{10} \frac{d_2''}{d_1''}.$$

*Prop. III.* Permeance between two equal parallel rectangular areas lying in one plane at some distance apart.—Assume lines of leakage to be quadrants joined by straight lines.

$$\text{Permeance} = 2.274 \times a'' \times \log_{10} \left\{ 1 + \frac{\pi (d_2'' - d_1'')}{d_1''} \right\}$$

*Prop. IV.* Permeance between two equal areas at right angles to one another.

Permeance (if air angle is  $90^\circ$ ) = double the respective value calculated by II. or III.

Permeance (if air angle is  $270^\circ$ ) =  $1\frac{1}{2}$  times the respective value calculated by II.

If measures are given in centimetres these rules become the following:—

$$\text{I. } \frac{1}{2} (A_1 + A_2) \div d;$$

$$\text{II. } \frac{a}{\pi} \log_e \frac{d_2}{d_1};$$

$$\text{III. } \frac{a}{\pi} \log_e \left( 1 + \frac{\pi (d_2 - d_1)}{d_1} \right).$$

*Prop. V.* Permeance between two parallel cylinders of indefinite length.

The formula for the reluctance is given on p. 566 (ELEC. REV., November 7th): the permeance is the reciprocal of it. Calculations are simplified by reference to Table VIII.

(To be continued.)

### NEW PATENTS—1890.

16752. "Improvements in electrical switches." T. R. ANDREWS and T. PREECE. Dated October 21.

16792. "An improved arrangement of regulating device for electric arc lamps." A. DE PUYAT. Dated October 21.

16809. "Improvements in electric blank heating and feeding apparatus for forging machines." G. D. BURTON. Dated October 22. (Complete.)

16811. "The improvement of switchboards for the regulation and control of electrical currents." P. G. POCHIN. Dated October 22.

16835. "An improved electrical conductor for fitting in mine shafts and underground haulage roads for electrical signalling purposes." W. CAIRNS and A. F. MABON. Dated October 22.

16837. "Improvements in the manufacture, construction, and building up of secondary battery elements, electrodes or plates." J. E. DOUGLASS. Dated October 22.

16889. "Improvements in electromotors." R. KENNEDY. Dated October 23. (Complete.)

17018. "Improved joints or connectors for uniting wires or cables, temporarily or otherwise, for electrical or other purposes." W. BISHOP. Dated October 24.

17062. "Improved electric switch." J. P. BAYLY. (Communicated by C. Herrick, United States.) Dated October 25.

17063. "An improved electric lampholder and switch combined." J. P. BAYLY. (Communicated by C. Herrick, United States.) Dated October 25.

17108. "Improvements in dynamo-electric machines." G. PITT. (Communicated by R. Thury, Switzerland.) Dated October 25.

### ABSTRACTS

#### OF PUBLISHED SPECIFICATIONS 1889.

13168. "Improvements in means for supporting electric lamps and in conductors therefor." A. McCANDLISH. Dated August 21. 6d. To a permanent or temporary magnet there is attached an elastic medium, such as springs made of metal or India-rubber,

for arresting the vibration; to this elastic medium is fixed or suspended the "electric" lamp. 3 claims.

13510. "Lamp shades or reflectors for electric lamps." W. B. LAWRENCE. Dated August 27. 8d. The inventor takes a glass or other bulb, and beneath the apex or neck removes a lateral section thereof. He then surrounds the lamp with the remainder, thus forming a shade and reflector, and it is attached in the following manner:—The globe fits into a sleeve, which contains light wires. The sleeve in turn fits into a socket, on a bracket to which the light wires are applied, and it is held in position and attached by means of shoulder pins, fitting into a groove in the interior of the socket. 4 claims.

15958. "A method of and appliances for preventing excessive heating or undue expansion of electric mains or service conductors through excess of electricity, and for utilising such excess." F. W. ENGELBACH and E. B. BRIGHT. Dated October 10. 8d. A metallic slide bar, attached to the rod of the governor of the engine driving the dynamo-electric machine, is so arranged that it is lifted or lowered by the rising or falling of the governor. The slide bar is electrically connected to one pole of the dynamo-electric machine and makes contact successively with a series of metallic springs insulated from one another. If the apparatus is used simply to neutralise any excess of electricity in the electric conductors the springs are electrically connected to the other pole of the dynamo machine, but the size of the conductor from each spring is such that each spring acts as a shunt between the two poles of the dynamo-electric machine; thus gradually increasing the proportion of electricity diverted from the electric mains or service conductors as the governor rises. 5 claims.

16537. "Improvements relating to insulators for electric wires and to supports therefor." D. RYLANDS. Dated October 19. 8d. Instead of passing the wire around or on one side of the insulator as heretofore, the inventor arranges the insulator lengthwise in the direction of the wire to be insulated, and passes the said wire through a hole formed in the said insulator. 4 claims.

16978. "Improved arrangement of conductors for electric series traction." J. M. M. MUNRO. Dated October 28. 8d. Relates to the arrangement of conductors for carrying the electricity to the motors of vehicles driven by electricity, the object of which is to provide a system of conductors for series traction which will allow of having greater length of continuous conductors than has hitherto been in practical use. In this system the whole circuit is laid off in a number of sections, which may be equal to the greatest number of cars or trains intended to be run upon it at one time. 6 claims.

17115. "Improvements in electro-magnetic telegraph apparatus." F. X. BACHMANN. Dated October 30. 6d. The inventor provides a core connected to or made in one piece with the two pole pieces. The core is wound with a fine wire. The pole pieces rest upon a metal bar lying parallel with the axis of the core. The armature is pivotted to move in a plane parallel with the axis of the core, and at a point therein equidistant between the two pole-pieces. 3 claims.

17276. "An improved socket and adapter for incandescent electric lamps and other electrical purposes." G. DONOVAN and W. DONOVAN. Dated October 31. 8d. Consists in the construction of an adapter or socket of a form similar to the cap of the ordinary incandescent lamp, which is carried out by forming a cylindrical body having a projecting shoulder of smaller diameter of boxwood, porcelain, or any other suitable insulating material. Upon the said projecting shoulder a small piece of tube of brass or other material is fitted of such a size as to fit into the ordinary lamp holder, pins being arranged on the outside of the said tube, in order to engage as a bayonet joint in the lamp holder in the usual manner. Upon the opposite side of the cylindrical body to that on which the brass tube is fitted, a circular recess or groove is provided either of V or other suitable shape, and from such recess two tubes of brass or other suitable conducting material are led through the body of the socket or adapter, and extend to the same distance as the brass socket tube. Upon the ends of these contact-making tubes suitable contact plates of copper or other equivalent material are arranged. The space within the brass socket tube around the said contact-making tubes is filled with plaster of Paris or other suitable material, so thoroughly insulating the conductors from one another and from the surrounding fittings. 4 claims.

17317. "Improvements in electric measuring and regulating apparatus for use with alternate currents." W. T. GOOLDEN and SYDNEY EVERSHED. Dated November 1. 8d. The object of the invention is to render electro-magnetic measuring instruments, regulating apparatus, and integrating meters, with or without iron or other kindred material as the magnetic medium, suitable for the accurate measurement] and regulation of alternate currents. 6 claims.

17387. "Improvements in electric meters." J. OULTON and J. EDMONDSON. Dated November 2. 8d. Relates mainly to electric meters in which the current to be measured is made to retard or accelerate the vibrations of a pendulum or chronometric balance, the amount of such retardation or acceleration being the measure of the current consumed. 4 claims.

17763. "Improvements in or applicable to electrical switchboards and switches." F. L. RAWSON and W. WHITE. Dated November 7. 8d. The inventors form in an electrical distributing switchboard the connections to the two poles of the main circuit by means of two main bars of metal, which may be castings

arranged so that the connections are all on the surface of the board, the two mains of the dynamo being connected to these two bars at one end of each by means of suitable cable connectors. One of the main bars is made with projections on one side, which projections are bevelled off to allow the brushes as they are turned round to rise to the top of the bar, and so make a good contact for one end of the switch brush. The other contacts of the switch brushes, which may also be castings, are bevelled off where the brushes rise on to them, and are provided with projections to receive the terminal screws under which the ends of the fuses are clamped, the other ends of the fuses being clamped under terminal screws on to suitable plates, at the other end of which plates cable connectors for the external circuits are clamped down with a nut. All the contact plates on the surface of the board are the same height, and are all flat on the top, so that they can be all planted on the board, and filed or planed over at one operation, thus making the production exceedingly cheap and simple. 4 claims.

18343. "Improved safety cut-out apparatus for a network of multiple electrical conductors." SIEMENS BROS. & Co. (Communicated from abroad by the firm of Siemens and Halske, of Berlin.) Dated November 16. 8d. Claim:—In a network of multiple electrical conductors, the use of safety cut-out apparatus connected with all the conductors, and so constructed and arranged that when the current in one of the conductors becomes too strong, it effects automatically the interruption of all the conductors, such apparatus consisting either of an inflammable mass in which the safety fuses of all the conductors are imbedded, or of an electro-magnet included in the circuit of each conductor, the armature of which controls a cut-out switch for all the conductors, or of any equivalent device for carrying out the above-named object, substantially as described.

## CORRESPONDENCE.

### The British Insulated Wire Company, Limited

I notice in the current issue of your valuable paper, which has just come to hand, a short reference to the "Norwich" cables made in this country by the British Insulated Wire Company, Limited, in which you remark, "There is apparently no attempt to make any test which the merest tyro in a submarine cable factory would know to be necessary." You are good enough to qualify your critique by the term "apparently," and I am glad to be able to inform you that this defect is apparent only and not real.

Of course a new and untested material before coming into practical use requires to be experimented upon exhaustively, but where a given class of cable has been in practical use for some years, doing its duty successfully under various conditions, many of which are most trying, I think you will agree with me that the value of laboratory tests are somewhat discounted as a means of proving the capabilities of manufactures under a given process.

At the same time, as an independent opinion though useful is but that of an individual, and therefore likely to be slightly faddish, it is most satisfactory to have such judgment corroborated by all possible tests, trials, and coincidence of opinion generally, and this, be it noted, is the case on the matter referred to.

The company have been good enough to hand me for perusal several reports by distinguished scientists and well-known practical men, and I find that the figures quoted are those, within a very small percentage, obtained in the tests made by me. On careful consideration of my letter to the British Insulated Wire Company, Limited, you will see that it is only a "memo." prior to furnishing a report which is now completed, and contains all the possible data and results of a series of tests on the "Norwich" telephone and electric light cable. Also I referred to some experiments on "Hygrometric absorption" in my memo., so that the cable has been "submitted to the action of damp, and its insulation has remained unimpaired." Regarding your interpretation of my remark as to maintenance of high insulation at a high temperature, reference might be made to some statements by Mr. David Brooks, in January, 1886, as follows:—

"All of the recognised insulating materials are affected by temperature. The insulating property of

gutta-percha is 100 times higher at + 100° F. than at the freezing point." "Textile coverings like cotton, flax, hemp, jute and manilla show entirely different results. These materials in a natural state may be classed as conductors."

The company are in possession of complete and reliable data of a set of tests made in different ways and at different times, and no doubt they will be prepared to furnish you with these at an early date for your complete satisfaction.

Charles H. Yeaman.

Electrical Testing Room, City of  
Liverpool, November 8th, 1890.

Being a subscriber to your valuable journal, and a pretty constant reader, I saw the notice you honoured the British Insulated Wire Company with in your issue of the 7th inst., and have nothing to complain of in your remarks except, perhaps, the concluding sentence, viz., "the practice (so common) of attracting the unsuspecting public by reports which are not worth the paper they are written on, cannot be too severely condemned."

Had it not been that the company must be advertised to comply with the terms of the underwriting letter, the "unsuspecting public" would never have been asked to buy a share, as every underwriting contract being by personal friends was a *bonâ fide* purchase and not a speculation.

I had intended, and still intend, sending you fullest details of tests of this make of cable, and hope to do so within the next few days.

R. E. Crompton, Esq., is not acting in the dark, as he was good enough to put some of these cables into service in the early part of this year, and has nothing but praise for them.

My object in troubling you with this letter is to show you that no imposition on the public was designed, or a precedent for a very different policy could readily have been found.

J. B. Atherton.

November 11th, 1890.

### Life of Glow Lamps on the Series System.

In the discussion on Mr. Bernstein's Paper on the "Series System," read in the Institution of Electrical Engineers in 1886, Mr. Mordey expressed the opinion that lamps on a circuit of constant current must of necessity be shorter lived than lamps on a parallel circuit, the reason being that the resistance of lamps rises in course of time. If placed in parallel, they will then take less current, give less light, but have a considerable preservative power.

This view appears very plausible, and it will therefore be of interest to many readers to hear that a Bernstein lamp, which was placed in a circuit of constant current of 10 ampères in Niagara-in-London, has been in use more than three years every night except Sundays, and has already lasted more than 10,000 hours. During the present year it has been run 12 hours daily.

The system on which this lamp has been run is known as the Wood's system of arc lighting, and is owned by the Fort Wayne Electric Company, of Indiana.

Frank Lott,  
Electrical Engineer in charge,  
"Niagara-in-London."

November 7th, 1890.

[A. E. MUIRHEAD.—The telephone receiver you mention is apparently similar to that of Silvanus Thompson, the Stanhope, and others, and also to the one known as the "English Mechanic" receiver. If this is so, we believe it is no infringement of the Bell patent.—EDS. ELEC. REV.]

THE TELEGRAPHIC JOURNAL AND  
ELECTRICAL REVIEW.

VOL. XXVII. NOVEMBER 21, 1890. No. 678.

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OUR DEFENCES.

THE subject of our defences is one which, possibly, it may be argued, does not strictly come within our province. It is not for a technical journal, professedly an electrical organ, to encroach upon what may be regarded as the domain of military or naval administration. Nor is it in any such spirit we approach the question, but rather as a representative of a factor—and an important factor—of that force which must form an element in the consideration of the subject.

Regarded from that narrow and circumscribed standpoint which looks at everything which is said and done, as the outcome of some selfish and personal interest, it will possibly be said that the remarks we have to offer are prompted in the interest of that branch of manufacture, and in the extension of that application of science which we represent. We will ask our readers, and our critics, to believe that we are capable of being animated, as we think we have not unfrequently shown, by other and more noble desires. The subject to which we desire to direct attention is doubtless one which may be more forcibly brought under the notice of the general public by our influential daily contemporaries, and we very heartily and very earnestly seek their co-operation.

It is now some year or more since we, in referring to the Naval manœuvres which had then come to their close for that year, called attention to the need of providing for the defence of many of our chief seats of mercantile naval commerce. The proceedings of the attacking force then illustrated how deplorably all our mercantile ports were open to attack, and we suggested that it would be well for the Government and the nation to take into consideration what would be the position of our commerce and our coast defences were we brought face to face with a real, instead of an artificial, enemy. We then suggested the desirability of establishing, at various points, dépôts of such material as might be stored, against the moment of its requirement. What steps have been taken towards

this, or towards any other means of defence, we fear has been exceedingly small; so small, that were England placed upon its defence to-morrow, her only chance would be that sheer bulldog tenacity—that determination never to be beaten which has characterised our forefathers in all our engagements, which would have, if possible, to pull us through. How far this would be successful with the scientific advances made by other nations is an open and a somewhat doubtful question. British pluck and British determination will go a long way where the weapons are equal, but is our provision on an equality with our neighbours. What steps are we taking for the defence of our commercial ports? As we previously pointed out, supposing it should become necessary to lay down a series of marine mines for this purpose, what provision in men and material is being made towards it? Is it not a fact that, so far as the country is concerned, there exists but one recognised source, viz., the Royal Engineer corps, for furnishing the former? Is it possible they could meet such demands, and at the same time comply with the requirements of that duty for which they were primarily created? Why, then, if civilian aid is to be called upon, are we not establishing it? We have no lack of volunteer enterprise for other branches of military or naval defence; but here we are dealing with something novel—something which requires, and must have, the support and recognition of the Government; which must, in fact, be initiated by that authority. Are we so supine as to suppose there will be time to organise all this when we get notice of its need? To be prepared is not to court war—rather the reverse. Neither England nor any other country can afford to stand idly by waiting till the time comes for action. All must be prepared, so that should that time, unhappily, ever come, action may be prompt and decisive, as we may rest assured it will be by others, if not by ourselves.

Our attention has been more than ever forcibly directed to the subject by a paper read before the New York Electrical Society last month, and which we pub-

lished in full in our previous number. This paper was from Lieutenant Fiske, of the United States Navy, and is entitled "The Civilian Electrician in Modern War." Lieutenant Fiske's name will probably be for ever associated with the tactics of American naval warfare and coast defence, for to him certainly will belong the inception and the credit of applying electrical science to those objects. The paper is one which might well be considered by our authorities and by the public at large interested in home defences. It is necessary we should be alive to the fact that electricity, as stated by Lieutenant Fiske, "has come into use as one of the great factors in warfare, both on sea and shore, not as an adjunct merely, as for lighting ships and forts, but as a vital element in the handling of weapons in actual battle, and in the construction of new instruments which accomplish things heretofore impossible." The modern war ship, if to be used as a concentrated mass of energy, to overwhelm and crush her adversary, must be capable of being handled, as Mr. Fiske states, from one central point, by one individual, so placed that he can see and command all around him. The handling of such a vessel, the direction of her guns, the moment of their discharge—all this, together with a multitude of other minor matter, all come within the provision of electrical agency. The illumination, the healthfulness of the vessel, are aided by its means, and by its means she may surround herself by a cordon of explosives against which her opponent dare not dash herself. On board ship the fighting officer must be in the midst of the smoke of the battle, but on land this need not be so. Stationed apart from the smoke, the noise, and confusion of the attack he may, at a distance sufficient for his purpose, observing all that passes, guide the defence by the aid of that power which also enables the gunner to concentrate his battery, and to discharge it at the point, and at the moment when it shall deal its most efficient blow.

Still, multitudinous as are the applications of electricity to forts and to ships, in torpedo or submarine mining, it will be found of no less importance; and, as we have previously urged, no more ready, no more speedy means of preparing for defence exists than is to be here found. But how can it be used, how can it be installed without men capable to handle such work. It is idle to look to the War Office resources as they at present stand. Either the War Department should establish a corps, sufficiently large to deal promptly with the entire coast defence, or the Government should institute local volunteer corps, officered and manned, subject of course to the responsible local military authority, by local residents. Every facility should be afforded such corps for practice. Depôts of material should be established, and everything necessary for actual defence, as far as possible, provided for. The Mersey, the Clyde, the Tyne, the Thames, and other important and strategical points would not be slow were it announced that the Government were prepared to deal with this subject in a broad and liberal manner, in responding to such a call. In no other way do we see it possible to approach this most important question.

We heartily commend Lieut. Fiske's paper to the perusal of our naval and military authorities. From it they will learn to what extent others are preparing for the dire emergency of war—a war which, when it does come, will be one in which science, and especially electrical science, will play the most important part. When war comes, no matter what our preparation may be, it will still find plenty wanting. Let our preparations be ever so great, let us feel that we are even prepared, and there will yet be far more to do than can be done at the time. How, then, if we are found as we are at present? We heartily trust that our contemporaries may, as we suggest, take the question up and bring to bear upon it their influence, and that the result may be that movement we are so desirous of seeing—a movement on the part of the authorities to provide the necessary means for the defence of our coasts, and a responsive movement on the part of those who possess the ability and the time to volunteer their services for the work.

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Count Mattei's  
Remedies.

WITH commendable zeal Mr. Alfred W. Stokes, public analyst to Paddington, Bethnal Green, and St. Luke's, has undertaken an investigation into the genuineness of the "Electricities" remedies of Count Mattei. Mr. Stokes states, as the result of his investigations, that as regards the liquids "To delicate test-paper they were perfectly neutral. Vegetable extracts are usually either alkaline or acid; even if neutral when fresh, they speedily change. They had the following characters:—Colour, odour, taste, polarity, metals, and alkaloids, none; specific gravity (distilled water = 1) 1·0006 *elettricità bianca*, 1·0002 *elettricità verde*, 1·0002 *elettricità rossa*; solid matter in 100 parts, 0·01 *elettricità bianca*, 0·01 *elettricità verde*, 0·01 *elettricità rossa*. The microscope showed an absence of any floating particles or sediments such as are usually present in vegetable extracts. There is but one substance which possesses all the above qualities, that is water. None of these fluids differ at all from water in any of their properties." So far the analysis seems to have been conducted in a reasonable manner, but when we come to the electrical investigation we find as gross an ignorance of elementary electrical laws displayed as can well be imagined. Mr. Stokes writes:—"To find if they possessed any special electrical properties, they were placed singly in thin glass tubes; these tubes were suspended by silk filaments. Under such circumstances an electrical body would point one end to the north and the other end to the south. Not one of these came to rest in such a position; neither were any of them attracted by a magnet, as an electrical body would be. Hence, they certainly are not electrical." Comment is needless. Mr. Stokes should be at once secured by Mr. C. B. Harness.

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Something out of  
Nothing.

"NOTICE is given of the closing of the transfer books of Elmore's Foreign and Colonial Patent Copper Depositing Company for the purpose of paying a dividend." So say the newspapers. This dividend must, of course, be out of the floating of sub-companies. What too strong can be said of this whole business of floating company

after company without having once proved the intrinsic value of the Elmore process? Only company promotion and dividends therefrom support the fiction, but none the less evil will be the day when all the facts connected with the process and its present handling are known, and they cease to tempt either the ignorant investor or him who hunts for premiums.

The Loss of the  
*Serpent*.

THE excuses, or reasons, given for the loss of H.M.S. *Serpent*, such as the effect on the compasses produced by the vicinity of large quantities of iron ore on land, the "humbugging" of the compasses owing to the magnetism of the hull being affected by the buffeting of the waves, and the ship's course being thrown out by a strong current, savour of too much protest on the part of those in authority. Thousands of merchant steamers are continually passing Finisterre, and unless a merchant captain had some better excuse to give than either of the above for the loss of his ship, his certificate would be in considerable jeopardy.

Another Subway  
Explosion.

ON Wednesday afternoon, last week, another alarming occurrence took place in connection with electric lighting in Newcastle, at the corner of Pilgrim Street, New Bridge Street and Northumberland Street. A few days ago, it will be remembered, the cover of an electric light junction box in the pavement blew off in that neighbourhood. On Wednesday afternoon, a puff of smoke was observed to issue from the same box-cover. Nothing further happened to this box, but the covers of two other boxes in the locality almost immediately blew off. Fortunately, at the time of the occurrence, comparatively few persons were about, and no one was injured. The utmost alarm, however, was felt by the residents in the locality owing, as stated, to a similar accident having occurred so short a time ago. The opinion expressed by the workmen is that the explosion had been caused through an escape of gas. Writing to us on this topic Mr. Arthur E. Gilbert makes the following comment:—"Surely my system of ventilation, which you illustrated some months ago, would obviate these serious explosions. No ventilation appears to be provided for, or even considered essential, but for safety I think you will say it is essential."

Some Experiments  
in Electrolysis.

IN a recent issue of *The Chemical News*, Mr. P. L. Aslanoglon describes some rather empirical experiments which he has conducted on the electrolysis of various substances. He passed the current from six Fuller's mercury bichromate elements through various solutions and obtained the following results:—Water containing calcium, magnesium, barium, strontium, or zinc hydrogen carbonate yielded, when the current was passed, a deposit of the normal carbonate of the metal at the negative electrode, and at the same time both oxygen and hydrogen gases were evolved. There was the same evolution of gases when the current was passed through a solution of ferrous carbonate, but the carbonate remained unchanged: there was no deposit. A solution of silver chloride in aqueous sodium thiosulphate, yielded under similar treatment a deposit of metallic silver: hydrogen was evolved, but no oxygen. In this case an odour of sulphuretted hydrogen was observed. When lead sulphate dissolved in ammonium tartrate

was subjected to the same treatment, a black substance was deposited at the negative pole: it gave off an ammoniacal odour. The positive pole and the liquid became yellow, and there was an evolution of oxygen and hydrogen gases. It is a pity Mr. Aslanoglon's work has not been quantitative. We need hardly point out how much more valuable such researches are, and it is to be hoped that the experiments will be repeated with solutions of known strength, and that in each case the resulting substances will be carefully analysed.

Electricity.

THE new journal has appeared, and we notice an error in the second sentence. "Fifteen years ago," says the editor, "a paper exclusively devoted to electrical matters would have had no *raison d'être*," and yet the ELECTRICAL REVIEW has been steadily making its way since the year 1872. The candid admission, too, that it is not intended to supersede any of the existing papers is welcome news, and once again we wish our penny contemporary a flourishing future.

Electricity.  
Daily.

THE *Elektricitäts-Zeitung*, of Berlin, a bi-weekly journal of fifteen issues, is now announced to appear three times a week. The editor is Arthur Wilke, and the hope is expressed that in the near future the paper may appear every day on the breakfast table of those people interested in electro-technics, in common with their other daily periodicals.

Fire at Grosvenor  
Gallery Station.

ON Saturday last the Grosvenor Gallery Central Station, belonging to the London Electric Supply Corporation, was destroyed by fire. The place was left in charge of a linesman, who, while endeavouring to switch off a converter, failed to firmly fix the plug between the two terminals, which caused an arc to form. The details of the mishap, which in less than an hour's time left the station completely gutted, are given in another column, but doubtless the fear of getting a shock from a current of 5,000 volts pressure, even if such a thing were impossible, was the cause of the man's loss of nerve. The instruments and converters were destroyed, business for the present being entirely suspended, and, will it be credited, the loss is not covered by insurance. Coming to the cause attributed in the foregoing remarks, there appears to have been some laxity in a method of management which leaves an inexperienced man in such a responsible position, for inexperience and responsibility are shown by the results. Grave censure is without doubt due somewhere, but one could not for a moment cast blame upon a man who is actually admitted to be new to the work. We are afraid customers who may have been entirely dependent on the supply of current for light may not take a too favourable view of the accident. It must not be thought, however, that we fail to appreciate the many difficulties and troublous times through which the company has passed, and this crowning disaster, coming as it has just when the Deptford Station seemed to promise to keep up the complete supply for the company's system, is doubly disheartening, and we sincerely sympathise with Mr. Ferranti and his supporters, and express the hope that they may soon tide over their ill-luck.

## GENERAL INSTRUCTIONS FOR OVERHEAD LINE CONSTRUCTION FOR ELECTRIC RAILWAYS.

THE large amount of overhead railway work now in course of construction, and the large number of roads which will undoubtedly be constructed in the future, makes it desirable to have some clearly defined rules for the construction of overhead work, as well as that relating to the ground conductor. Our readers (*New York Electrical Engineer*) will therefore be interested in the admirable general instructions relating to this part of railway work, which have been issued by the Westinghouse Electric and Manufacturing Company, and which, if carried out faithfully, cannot fail to result in a substantial and lasting conductor system, with the least possible annoyance to the public.

**Franchises, Permits, &c.**—The owners of the railway must secure all necessary franchises and permits from public authorities, or private individuals, for properly carrying on the work of construction, including permission to set poles in the most advantageous positions, and to run guys where necessary. They shall also do all necessary removal or trimming of trees, and shall be responsible for all necessary removal of existing wires or poles or other impediments.

**Contractors.**—The contractors shall comply strictly with the local laws governing their work, and are responsible for all unlawful damage done by their employes in the progress of their work. They are required to do all the carting and storing of material, to furnish all horses, waggons, men and material for carrying on work.

**Completion of Work.**—Each branch of the work must be pushed rapidly to completion as taken up, all re-sodding, paving, &c., promptly done, and all debris and material removed. All breakdowns, or deteriorations of the work, which shall occur before the final completion and acceptance of the whole, shall be repaired and made good by the contractors at their own expense.

**Inspection and Acceptance of Work.**—The Electric Company may appoint an inspector, who shall have authority to decide and direct how every branch of the work shall be done, and what material shall be used. He may at any time order such changes and removals as he may see fit. If the inspector orders any work done or materials used which are not properly included in, or covered by, the contract, he shall give a written order to the contractors, specifying, as nearly as possible, the amount of labour and material involved. The inspector will give a written acceptance to the contractors when he considers their work properly completed.

### TRACK AND GROUND CONNECTIONS.

On all roads where the size and material of the continuous ground wire are not particularly specified, No. 0 B. and S. galvanised iron wire shall be used. All joints in it shall be soldered. It shall be stretched taut, and secured to cross-ties or stringers with galvanized staples. It must be so deep in the ground that it cannot be reached by wheels, &c. It must be run close to one rail, and connected to each rail bond it passes by a wrapped soldered joint. Every 150 feet a branch of No. 0 B. and S. wire shall be soldered to the continuous ground wire and to a rail bond on the other side of the track. Where there is a double track, there must be a cross wire every 150 feet, which is soldered to bonds on ground wire on all four lines of rail, and is the only cross connection required. It must be of No. 0 B. and S. (See fig. 1.)

Between the ends of all consecutive rails, of whatever form, a rail bond, the Electric Company's standard pattern, shall be used. This bond is shown in fig. 1. The holes in brass or copper block must be bored to fit rivet and wire, not punched. The end of wire must be put through block, and upset so that it cannot pull out, and the whole bond must be covered with half-and-half solder. The rivet must be Norway iron,  $\frac{1}{8}$  inch

in diameter, and of just sufficient length to pass through flange or web of rail and be riveted.

The best place for rivet holes in different kinds of rails depends to a great extent on paving and other conditions. The rivet must always pass through the rail, and be upset into a counter-sinking at the end of hole. No part of the bond must be exposed or placed in such a manner that it can be touched by wheels or that the movements of the rail will tend to break the wire. The admissible positions for rail bond rivets in girder, T and tram rails are shown (fig. 2). No rail bond may be less than 10 inches in length, and the bonds must be slack when in place, but as short as the conditions will permit. Where short pieces or castings, such as switches, frogs, or curve castings, occur in track, the pieces must be connected up in the same manner as consecutive rails, and each bond soldered to the continuous ground wire.

In steam railway crossings, each piece of rail must be connected to the continuous ground wire. Where a draw bridge is crossed the rails on either side should be connected by a No. 0 B. and S. copper wire, weighted to the bottom of water, with such connection as is necessary for rails on draw.

Cables or wire leading from rails to dynamos must be soldered to continuous ground wires and bonds on all lines of rails, and must be connected to the positive terminal of dynamos. When ground feeders are run, they must be insulated in the same way as line feeders, but must, if possible, not be run on the same line of poles, and in no case must they be run on the same insulated pole tops.

### POLES.

**Wooden Poles.**—Must be 30 feet long, and, for use on straight lines must not be less than 7 or more than 8 inches in diameter at top when finished, and they must not be less than 10 inches in diameter 5 feet from the butt. They must be of sound chestnut, cedar or Georgia pine, may be sawed or natural round, but in both cases must be dressed smooth and coned at top, cones having two coats of paint.

**Poles for Corners.**—At curves, and for the ends of line, or which in any way bear part of the pull of the trolley or feed wires, must be not less than 8 inches in diameter at top and not less than 12 inches at a point 5 feet from the butt. All poles must be straight and uniform and free from shakes, checks or large knots.

**Iron or Steel Poles.**—Of whatever form shall be of a strength and stiffness at least equal to the wooden poles specified. A pole made of three sections of extra heavy pipe, top section 3-inch pipe 5 feet long; middle section 4-inch pipe 6 feet long, and bottom 5-inch pipe 16 feet long (these lengths do not include the lap in joints), is sufficient for light work. All joints must be made perfectly rigid and as strong as the adjoining pipe, with proper provisions against telescoping.

All iron poles must have a thoroughly insulated iron top, to which wires are secured. This should be mounted in a hard-wood plug in pole top, boiled in paraffin. The top must protect the plug entirely from water; it must have a deep petticoat extending at least 1 inch below pole top, and standing at least 1 inch clear of it on all sides. This top must be fitted with fixtures for securing span wires and insulators for feed wires, &c.

**For Curves.**—Angles of feed wire, and ends of line, &c., extra strong poles must be used. There is nothing in the work of building a line so essential to its durability and good working as is the perfect rigidity of corner poles. The top section of curve poles should in no case be less than 5-inch extra heavy pipe, and, of course, special insulated tops must be provided for them. Corner poles must be fitted with strong eyebolts below the wooden plug for fastening guys.

**Pole Setting.**—All poles on straight line work shall be set 6 feet in the ground. Large stones shall be tamped hard against butt of pole on side away from rails. Where practicable, pole should bear at surface of ground against curb stone, or have the space between it

and curb stone filled by another stone or stones. Where there is no curb stone, a timber not less than 4 x 8 inches and 3 feet long shall be laid against the rail side of pole, 6 inches below the surface of the ground. A large stone, at least 2 feet long and 1 foot

diameter, and filled with concrete, which should be given ample time to set before any strain is put on it. Poles of wood or iron for straight line work should have about 3 per cent. of rake away from street. (Fig. 3.) Wherever possible, the line of the tops of poles

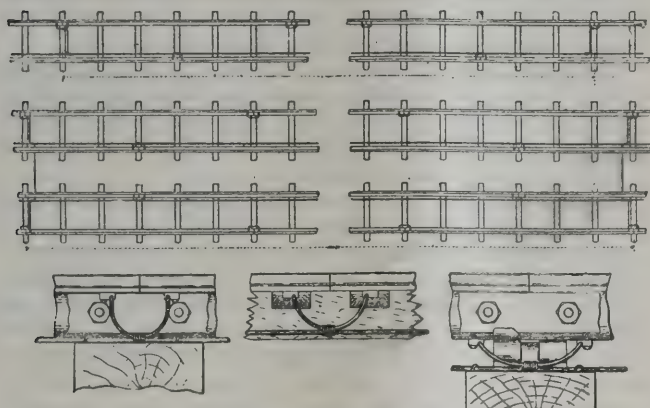


FIG. 1.—METHOD OF CONNECTING GROUND WIRE, SINGLE AND DOUBLE TRACK.

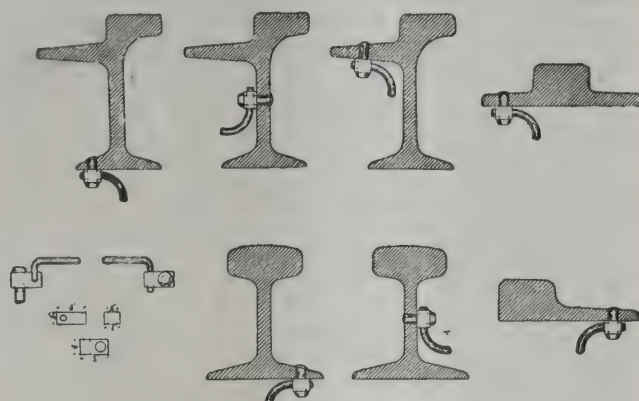


FIG. 2.—METHOD OF CONNECTING GROUND WIRE TO RAIL.

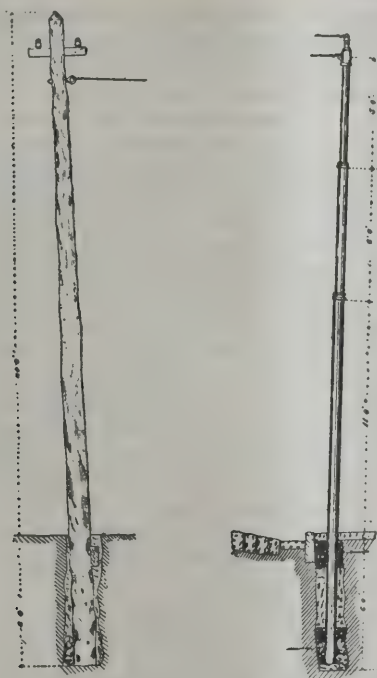


FIG. 3.—METHOD OF PLANTING WOOD POLE AND IRON POLE.

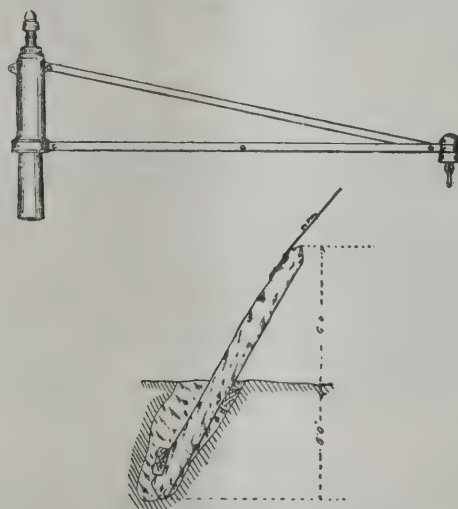


FIG. 4.—GUY STUB AND OUTRIGGER.

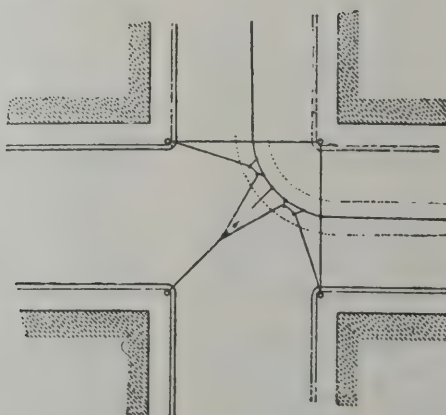


FIG. 5.—METHOD OF CONSTRUCTING OVERHEAD CURVE.

wide, should be used in place of timber when practicable. All poles shall be tamped solidly. (Fig. 3.)

In setting iron poles, good cement concrete must be used. The quality of the concrete should in all cases be good at the top and bottom of holes, and large stones may be used at these points to advantage. The hole in which an iron pole is set should be at least 20 inches in

should be at a uniform height from rails, and the ground around poles should be graded to give the pole the proper depth of setting.

Poles which support part of the strain of curves or bends of trolley or feed wires must, in all cases where it is possible, be thoroughly head guyed. When this can be properly done, no extra precautions need be

taken in setting, and poles should be set nearly vertical. The same applies to poles which support ends of lines.

Guy stubs must be anchored 5 feet in ground, and their tops must be 6 feet above ground; the stubs must be at least 8 inches in diameter, and must rake well towards pole top or point directly towards it. Guys must make no metallic contact with insulated pole tops or with any other wires which lead from the pole. Guys must be made of twisted (doubled) No. 6 galvanized wire or something equally strong and durable. (Fig. 4.) When guys cannot be used on the poles above-mentioned, they must be set 7 feet deep in a hole 30 inches in diameter, and built in solid with stone and concrete. Poles shall not be more than 125 feet apart, except where a greater distance is unavoidable.

In all cases where the character of the soil or the nature of the strains make the ordinary method of setting poles inadequate, precautions must be taken to make poles sufficiently firm, and whenever poles yield under the strain put upon them, the Electric Company's inspector may have them reset at the contractor's expense. This may also be done when poles are displaced by undue strains imposed by contractors in building line, &c.

When the poles are not set by contractors who put up the wires, the latter must assume responsibility for the rigidity of curve and terminal poles, and their work can in no case be made acceptable unless these poles are thoroughly strong and firm or properly guyed.

#### FIXTURES.

All insulator pins and pin brackets shall be of the best oak or locust. Pin brackets shall be secured to pole with one 5-inch and one 7-inch lag screw.

*Cross Arms.*—Shall be of the best pine,  $3\frac{3}{4} \times 4\frac{1}{2}$  inches, painted with two coats of Indian red. They must be secured in perfectly fitted gains with two 7-inch lag screws. Insulators must be extra heavy, such as are made for the largest sizes of wire. Where sharp turns are made with heavy wires, two or four cross arms must be used, and, where necessary, iron pins and large paraffined wooden insulators may be used.

#### WIRE CONSTRUCTION.

*Span Wires.*—Are to be of stranded wire,  $\frac{5}{16}$ th inch in diameter, made of seven wires without a core. They must be secured to eye-bolts, which pass through pole, and have a nut on the opposite side. These bolts to be of  $\frac{1}{2}$ -inch galvanized iron. With iron pole a suitable eye must be provided for span wire. The height of eye-bolts from the rail must be uniform on streets of equal width, and must be such as to hold the trolley wire at a height of 19 feet from the ground. A span wire must be allowed to sag about 3 per cent. of its length. When first put up, span wires must be left with one temporary connection, and must be carefully pulled up to uniform angle after trolley wire is run. They must in no case be connected so that slack cannot be readily taken in.

Span wires proper are only to be used where the line is perfectly straight. Where there is any lateral strain on trolley wire, double pull-off brackets must be used, with wires of the same material as span wires, leading to opposite sides of street.

*Trolley Wire.*—Must be put up in as long lengths as can conveniently be handled. The ends must be secured to a long V made of double  $\frac{5}{16}$ th stranded wire, and led from securely guyed poles. It must be connected to this V by an insulator of suitable strength. Trolley wire must be drawn to a moderate tension only, allowing about 18 inches of sag in 125 feet. In hot weather it should be drawn slightly tighter. It must be run off large reels, on which it is carefully wound; it must not be bent, kinked, or scratched. The practice of temporarily securing long lengths of trolley wire, and allowing by guess work for each curve is not approved, as it is sure to cause inequalities of tension in line or improper position of curves. Curves should either be completed as they are reached by the trolley wire, or

should be built successively after the wire is up, an ample amount of slack being provided and carried ahead as the curves are completed, the line being permanently drawn to the proper tension, and bridled as each is reached.

The hanging line insulators which support the trolley wire shall be clamped on (not soldered) after the line is accurately in place, and all curves completed.

Joints in trolley wire shall be made in suitable brass tubes, with tapered sides; they must be soldered by pouring, must be wiped smooth, and must bear a strain equal to the strength of the wire itself. Joints shall not occur in or near curves.

*Construction of Curves.*—The positions of poles near curves should be carefully selected, and the poles must be permanently guyed, or otherwise properly strengthened, before work of running trolley wire begins. At the beginning and end of each curve the line must be bridled to the corner pole, and one on the opposite side of the street. The fixtures for these bridles serve as the first and last pull-off brackets. They must be carefully swetted to the wire. Not more than five pull-off brackets should be used between these bridle fixtures on a 90 per cent. curve, except where the curve is very long.

*Pull-off Brackets.*—The pull-off brackets shall be at equal intervals and soldered to the wire. They must be so placed that the trolley is exactly in line with the wire as it passes them. To accomplish this, the bracket must be more or less inside of line vertically over the centre of the track, the height of the wire, and the radius of the curve determining the position.

Pull-off wires shall be of the same material specified for span wires. They may be secured either directly to eye-bolt on pole or to a stout galvanized iron ring at a suitable distance from pole. On double curves, &c., insulators shall be used only on wires which run to poles. Where short wires are used to connect pull-off brackets (for instance, those which lead to the brackets on the inner curve) no insulators shall be used.

The weight of curves must be supported by double pull-off brackets, with wires leading to opposite side of street. Fig. 5 shows a sample curve. On all curve construction the greatest neatness and strength will be insisted on; the minimum possible number of wires and insulators must be used; the angling of wires must be advantageous; every wire must be made to serve as many purposes as possible.

Switches, crossings, circuit breakers, lightning arresters, &c., &c., shall be used when and in the manner specially directed.

*All Material and Fixtures.*—For line work shall be of the form supplied or specified by the Electric Company. All joints and connections in insulated wires shall be covered with three layers of the best weather-proof tape. All ungalvanized iron work and wooden insulators shall be thoroughly and neatly painted with P. and B. paint. Joints in feed wire must be of a neat, strong and approved form, thoroughly soldered. No telegraph joints will be allowed in wires larger than No. 0 B. & S.

*Feed Wires.*—These must be put up to gauge specified, and must be 97 per cent. of the conductivity of pure copper. They must be put up without kinks or injury to the insulation, and in lengths of not less than 500 feet. Feed wires must be led into the power station through suitable rubber or porcelain insulators. Every connection to the trolley wire must be made through one of the span wires, which must be fitted with an insulator at each end, and connected to the feed wire by an insulated jumper of No. 6 B. and S. wire, soldered to both. Connection to the trolley wire must be made by an insulated hanger, similar in appearance to the regular insulators. These span feed wires must be of the same material as regular span wires, but covered with the best weather-proof insulation. Where feed wires have to be led under water, the best armoured cables must be used, and suitable terminal fixtures.

*Guard Wires.*—Wherever there is great danger of crosses with telephone, telegraph or other wires, through their falling on the trolley wire, guard wires must be

used. They must be of No. 8 B. and S. galvanized iron wire, and must be hung to span wire of the same material as the ordinary span wires. Guard wire must be 18 inches or more above the trolley wire. They must be insulated from the span wires, and the span wires must be insulated from the pole tops. Porcelain insulators may be used, but must have no sharp edges.

On single track work, guard wires must be 4 feet apart, with the trolley wire midway between them. On double track work, three wires will be used, one 2 feet outside of each trolley wire and one in the centre. Guard wires should not be used except where the need for them is very positive, and where their construction can be made simple and effective. A complication of guard wires will always be a source of trouble.

*Outriggers.*—When the trolley wire is hung to outriggers instead of span wires, the insulators must be so constructed that they will bear the lateral strain from the wire where the line is not straight. The outrigger arm must be insulated from the pole when the latter is of iron. (See fig. 4.)

### THE ALTERNATING CURRENT TRANSFORMER SYSTEM IN SOUTH AMERICA.

[FROM A CORRESPONDENT.]

UNDER this title I have some months ago sent you a report on the extension of the above systems in the towns of La Plata and in Brazil. To this report I am now in a position to add some further particulars.

The *Companhia Luz Electrica*, in San Paulo, which, as I informed you, has undertaken the lighting of San Paula and Casa Branca, and has there erected central stations on the alternating current transformer system, has, in the meantime, extended its sphere of activity and its capital. It has undertaken the supply of water, enlarged its capital to five million francs, and has been re-constituted under the title "Companhia Aqua e Luz do Estado de San Paulo."

Above all, the new company has undertaken the extension of the central station at San Paulo, and is erecting an alternating current machine of the type  $A_3$  (for 50,000 watts), with the requisite motor.

The company has further concluded an agreement with the municipality of Ouritzba (the capital of the province Parana), and is bound to get the public lighting there in action by June, 1891, at latest.

At the distance of about 4 kilometres from the town there is water power, which has been taken into consideration as supplying the needful force for the installation to be erected. But at present, owing to torrents of rain, the annual flow of water in the river cannot be ascertained, nor the amount of water-power which will be available. Hence, in the first place, two alternating current machines of the type  $A_3$ , for 30,000 watts each, are being erected with two Steinmüller tube boilers and two steam engines by Tangyes, Limited, so that the electrical works will be driven by steam power during the first period. The central station will be erected close to the railway terminus, so that a supply of fuel may be obtained cheaply.

If on further investigation it is found that the project of using water-power can be carried out, a definite conclusion will be come to as to whether the works will be conducted further with steam-power, or remodelled to suit hydraulic power. After the decision of this question, the extension of the works will be taken in hand, so that the demand for private electric lighting in Ouritzba can be duly met.

The computation of the price of the electric light will be carried out according to agreement with the Municipality, after working for a year on the scale of 4,000 candles. The calculation for private lighting will be made after the works have been definitely completed.

### THE ELECTRIC LIGHTING OF BRUSSELS.

THE question of the electric light remains open at Brussels, says the *Independence*. The technical departments of the communal administration are studying the different propositions made to the city authorities, and the College and Council will shortly be called upon to give their opinion upon the various tenders. This decision will be grave and difficult. Among the specialists themselves the different systems are keenly discussed, the advantages of each being contested; and it must be recognised that the problem, of which it is easy to claim an immediate solution at a meeting, is singularly complicated. As to Brussels, the situation is rendered still more difficult by the private stations erected at different points, and each of them monopolising the lighting of an area naturally chosen under the most favourable conditions.

In a new study on this subject, M. Ch. Haubtmann declares himself in favour of a single station outside the agglomeration. He is certain that electricity, in addition to its qualities of hygiene and safety, is before everything the lighting *de luxe par excellence*, and if to-day its upward rise is somewhat hindered on account of its relatively high price, the day on which it adds cheapness to its numerous other advantages over gas it will take possession, as gas formerly did, of the most modest dwellings. This cheapness, it may be said, is in the hands alone of the engineer electricians charged with establishing central stations of electricity, and it is by having acquired that idea, that several large installations have been made abroad under economical conditions which are truly remarkable. To induce machinery to output to its maximum extent appears to be the domain of the engineers; but what the electrician must specially seek is to establish a system capable of successfully rivalling that which is already installed. We believe that, for the time at least, we must not reckon on obtaining a better yield from the dynamos than that which we have to-day, but we should exclusively limit ourselves to keeping down to their lowest extent the expenses of installing and the working of the stations, as well as the loss arising from the energy absorbed by the conductors, &c.

This programme, on account of the tolerance which municipal authorities grant to the companies tendering for the lighting, is occasionally easy to carry out. Thus, in America, besides the facilities which are given to these companies of erecting their stations in the centre itself of the sector which they are to supply, that is to say, most often in the centre of the town, no difficulty is raised as to their establishment of aerial conductors. It can easily be imagined that, under these conditions, if coal be cheap enough, the electric light can advantageously compete with gas. But if, on the contrary, as in England, and in London particularly, central stations in the interior of the city are not tolerated, nor aerial cables, the problem becomes singularly complicated, and presents great difficulties.

As to Paris, at first, electrical stations were allowed to be established in the centres of the quarters, but a report of M. Lépine, secretary to the Prefecture of Police, recommends their transfer beyond the walls of the *enciente*. An important city seeks to get rid of the vibration caused by the steam engine at night, which incommodes the neighbourhood of the central stations; without reckoning this, despite all the smoke consumers with which the furnaces are provided, they allow sufficient carbon oxide to escape to reveal to the least inexperienced person the presence of a central electricity station. In short, the problem of electric lighting in large cities may be thus formulated under most general conditions:—to have a station outside the city, and underground cables conducting the electricity to the sector, at a net price capable of competing with gas. This is not impossible now, for the establishment of the station in a place isolated from buildings, in proximity to the means of transport, will procure a real saving in working, and may be, in building over that installed in the centre of the city itself. In this case,

the type of boiler which appeared the most economical could be employed without having to take police ordinances into consideration; the furnaces could be placed in such a manner as to suppress troubles regarding fuel; and, in most cases, there would be cheap water, &c. Regarding steam engines, being no longer bound by the position, the types giving the best results could be adopted, and several reserve engines could also be kept. In a word, a number of advantages would be enjoyed which it is impossible to get in the centre of towns and cities; among others, water and fuel at lower net prices, and apparatus giving a maximum of yield.

An outside station will doubtless cost, in establishment expenses, as much as an urban station, because, in the first place, a larger one will be built, and more apparatus will be placed therein, than if it were in the city. On both sides there will be the same building expenses, but there will be more economical production in the case of the station outside the section. There is then a first advantage resulting from conditions imposed by cities; let us say at once that it is compensated by an inconvenience much more important, more especially as regards the value of the system of the company's working. We refer to the loss arising from the transport of energy, which is obliged to be carried on account of the distance of the place of production from the place of consumption, and the expenses of the first establishment of the conductors. The labours of Cabanellas, and some experiments of M. Marcel Deprez, have taught us how to get rid of the major part of this inconvenience by employing high tensions, so that, all allowance being made, an electrical station situated far from the city will be found in an excellent position to compete with gas and the existing urban stations, while admitting that these latter are still tolerated.

We have already had an opportunity of pointing out, when the lectures were given at the beginning of the year before the Belgian Engineers' and Industrials' Society, the great difference existing between continuous currents and alternating currents as regards safety. There remain to be examined to what exigencies should a central station be able to respond before furnishing light and energy. For that, it is sufficient to pass in review what the subscribers to an electricity company have a right to expect from it:—1. To be able at any hour of the day or night to light the required number of lamps, or take the energy which is necessary. 2. To enjoy a light at least as regular as gas; that is to say, without variation in luminous intensity. 3. Not to be at the mercy of a bad installation and canalisation, in understanding by that never being deprived of light, on account of accidents to apparatus, earth contacts, &c. 4. To have no chance of accidents or electric shocks, dangers from fire, &c. 5. To realise as much as possible a saving on the former system of lighting. These five subscribers' conditions are reduced to two for the concessionary company:—1. To possess a central works producing economically and a system of distribution absorbing scarcely anything. 2. To have a reserve system capable of meeting all eventualities, consisting either of accumulators or spare dynamos, according to circumstances.

For a central station, this security consists simply in furnishing, at any moment of the day, the quantity of energy required by the section which it supplies. From this point of view, a station should be able to pass easily from a maximum output to rest and *vice versa*, and that very rapidly, instantaneously even, if that be possible. For this there are two solutions: To employ batteries of accumulators ensuring the service without the aid of the dynamos for a certain time, or to have dynamos constantly ready to work. In adopting the system with secondary batteries, if the installation is large and situated at a distance from the section, the employment of high potentials becomes necessary; then, in place of having accumulators in the central works themselves, they can be spread over different parts of the line, so as not to be obliged to adopt too large batteries in tension. These accumulators will bring about the disappearance of one of the greatest

inconveniences of lighting workings which operate during a short period of the day only, thus giving a bad utilisation of the dynamo.

We will not here enter into the technical details of the installation. We will only mention in conclusion a point which is much contested—the question of the strength of the units of production, on which many engineers seem divided. Should the producing stock be divided as much as possible? Or, on the contrary, should we lay ourselves open to make large dynamos? Each of the two schemes having its good features, we think it wise to adopt a medium course. The small units have the advantage, in case of injury, of rendering useless only a small portion of the total producing power, but they require more room, necessitate greater watchfulness, and cost more for working expenses than larger ones. The larger units, if they remain for a short time out of working, cause a loss, by the interest of the capital which they represent, of the profit which is realised on them by overlooking, yield, &c.; but we believe we are able to say that in dynamos, which are but little susceptible to derangement, powers may be attained which prudence would blame if steam engines were in question. It remains to be known whether these dynamos will always work at full load, for it is evident that an apparatus producing below its nominal power works under very bad conditions of yield.

The system of working must, then, be established under such conditions that the dynamos may always work with their maximum of production. For this it suffices to divide the apparatus supplying the total energy into two groups—a group of small units, having a total power, spread over five or six apparatus, equal to the nominal power of one of the dynamos of the other group, composed wholly of large units. It will be immediately seen that with this system of working a large dynamo only works as much as is necessary to produce a similar result to that for which it has been established, and that in proportion as the work demanded increases, one or several of the small dynamos are introduced up to their total energy, a value for which they are withdrawn by again introducing a large unit. This process gives a maximum of yield from the apparatus, and necessitates but few supplementary establishment expenses.

## THE EVOLUTION OF THE MICROPHONE.

By A. M. TANNER.

THE object of the present paper is to demonstrate that the microphone did not spring into existence Minerva like, but was the production of a slow growth continuing through several decades; it has several prototypes as will be shown further on. In former articles, which appeared in the ELECTRICAL REVIEW, I drew attention to the fact that certain types of Trevelyan instruments, possessing carbon rockers and bearers, will, under certain conditions, serve as microphones, the most essential condition of course being that the rocking electrode should be made sufficiently light to be affected by ordinary sound waves. The instruments reviewed in the present article do not require a change of form or diminution of weight, but will at once serve as microphones or telephones, having variable contact current tension regulators. In the outset, in order to remove any doubt that may exist as to who first discovered the principle of varying the resistance in a galvanic circuit by electrodes of metal or other material resting in loose contact, one upon the other, and serving to change the tension of the current flowing across said electrodes, not by a mechanically applied pressure, but automatically by a mere change of position or difference of contact between the electrodes, it is necessary to refer to the *Comptes Rendus* of the French Academy of Sciences for 1878, page 131, where Count Du Moncel states that it was not until the year 1856 that he discovered the change of electrical resistance produced by

imperfect contact electrodes. This, of course, determines the date of Du Moncel's discovery, and in view of what follows, it is necessary to award the credit of prior discovery to Prof. Albert Mousson (just deceased at the age of 86 years), of Zurich. In the *Nouveaux Memoires de la Société Helvétique des Sciences Naturelles* for 1855, Vol. XIV., appears a lengthy paper of Prof. Mousson on the changes of the galvanic resistance of metals. Among other experiments, mention is made of the variable resistance between springs rubbing upon discs, just as in the electro-magnetic circuit breakers of Du Moncel, when he discovered that a light or strong contact between the contact spring and collector disc will produce a variable resistance.

In fig. 8 of the plate accompanying Mousson's article, he illustrates an experiment with two crossed

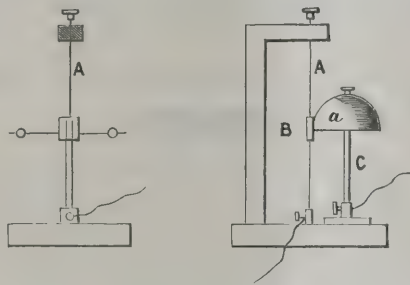


wires, and he adds that in a loose contact *without pressure*, as when two solid wires are placed one upon the other, the resistance is variable because of the changes of position, or changes of temperature at the contact points. The change of position of the loose contact electrodes is produced by the action of the current itself.

In the *Compte-Rendu* of the 45th session of the Société Suisse des Sciences Naturelles-Lausanne, 1861, is a communication from Prof. Mousson "on the movements that present themselves in a galvanic circuit at the points where the conductors touch each other very lightly." Mousson here describes the experiments of De la Rive in 1845, Rollman and Page in 1850, and Gore and Forbes in 1858, and says that they operated with rolling and rocking bodies.\* Mousson in describing his own experiments, says that for a "rocker" he selects a bar analogous to that employed in the Trevelyan experiment only *very much lighter*, and resting upon two knife edges brought close together, set in motion, while the current traverses the point of contact a sound is produced which results from the rocking of the bar on the two knife edges (bearers) and which continues as long as the current passes. Mousson adds that the movement of the "rocker" does not commence by itself, but must be started by an external cause, although sometimes an *imperceptible trembling of a table serves to set it in motion*. In order to better study the conditions of the movements produced by parts of a galvanic circuit in loose contact, Mousson employed an instrument by means of which the pressure of the contact could be varied. The "restoring force which in the rocking bar is its weight" is here replaced by the "torsional elasticity of a metal wire secured at its lower end and stretched by means of a screw at its upper end. A small plate fixed at the middle of the length of the wire carries two platinum knife edges, which run parallel to the wire, and are brought close together and bear upon a clock bell (small gong). The current passes to the gong through the wire and contact points, and the tension of the spring and the pressure are easily regulated in order to produce continuous vibrations, which acquire considerable force if they are in accordance with one of the sounds of the gong." Mousson here describes the results which follow when the pressure between the contact points is varied. He says that when the pressure is at zero the mechanical and galvanic contact is interrupted, no current passes, and the needle of the galvanometer does not move. When a slight pressure is applied a mechanical con-

tact takes place, but the galvanometer needle still remains at rest, because the galvanic contact is not yet established. This curious fact can no doubt be attributed to the *presence of a layer of condensed air*, which exists on the surface of all solid bodies, and which by resisting a slight pressure prevents metallic contact. When a greater pressure is applied it causes a mechanical and galvanic contact, but *it is always inconstant*. The needle oscillates constantly with greater or less force and is never in a state of repose. At the same time a slight hissing is heard like the long-continued sound of the consonant s. The current passes, but it constantly modifies the contact and the resistance presented by the same. Mousson attributes the change of resistance to calorific effects at the contact points, and says that the "variations of contact are produced without interruption of the current."

An illustration of Prof. Mousson's instrument as above described, is found in his work "Die Physik auf Grundlaye der Erfahrung," Zurich, 1874, vol. 3, page 412, fig. 942. The article relating to "movements produced by parts in light contact," describes the instrument as follows, viz., "The torsional elasticity of a strong wire, A, as shown in fig. 942, serves to hold contacts together. The wire is provided at the middle with an arm, B, clamped to the wire, and provided with two knife edges of platinum, which latter are held against a harmonic bell, C, conforming to the vibrations of the wire. When the current enters the bell at *a*, and passes out through the bell shank, light vibrations are caused by the agitation of the lever, which are reinforced by the bell, and are heard as a clear tone of considerable loudness.



I think it is almost needless to add that Prof. Mousson's instrument, as above described and illustrated, becomes a veritable microphone when "spoken to," and will transmit speech when used in connection with a telephone receiver. To show how carefully he studied the phenomena that are supposed to take place at variable contact electrodes, it is only necessary to say that Mr. Berliner, and others, have attributed the action of the microphone to the action of a "layer of condensed gas between the electrodes." Mousson, it will be seen, makes mention of this phenomenon. Then, again, transmitting-telephones have been constructed where the electrodes are held in contact by a torsion spring, very much as in the Mousson instrument.

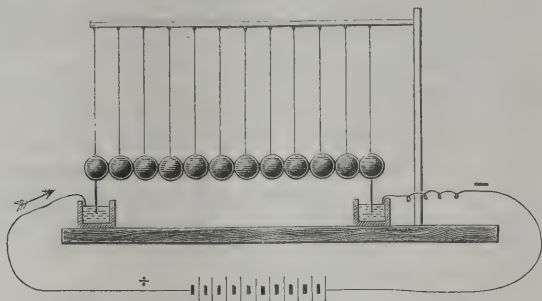
I now call attention to other references which disclose instruments that have a close bearing upon certain special types of microphones. It is undoubtedly well-known to those conversant with the history of the microphone, as disclosed by text-books, that the microphone of Boudet de Paris has a series of carbon balls placed in a glass tube, and which operate by impact, as "in the billiard ball experiment."

The French journal *Cosmos*, for 1858, vol. xiii., p. 148, has an article by Van Breda and Lorgeman intended to prove Ampère's law of repulsion. They state that "in carrying out their experiment they employed 12 iron balls, of some 8 to 9 millimetres in diameter, suspended as the billiard balls in the experiment on the impact of bodies, the centres of the ball being in line with each other. The two end balls have points which dip into mercury cups that are in communication with the poles of a battery of 12 Grove elements. When the current is made to traverse the balls the two end balls are repelled

\* These experiments and others were described in my previous articles.

from the others about one millimetre, and sparks are observed between each pair of balls."

Wiedemann, in his work "Die Lehre der Electricität," in referring to this last described experiment, which may be illustrated by the accompanying sketch,



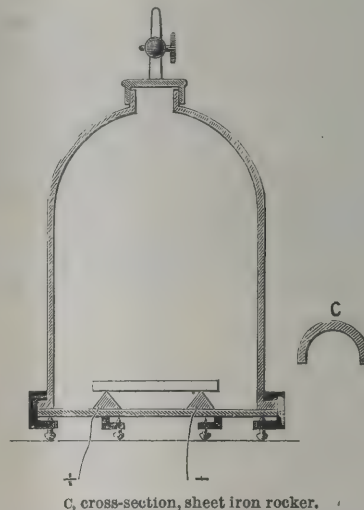
says that the passage of the current through the balls is attended by variations in its flow, according to the degree of contact of the balls and the calorific effects between the same. Wiedemann also states that the formation of sparks and the voltaic arc, together with the expansion of the electrodes by the calorific action of the current, can give rise to a vibratory movement of the electrodes between which such actions take place. If two carbon points are fastened to two elastic wires which by their pressure hold the electrodes together horizontally, then when the electric circuit is closed, a "clattering" noise like a series of small explosions is heard, and the passage of sparks and the formation of the electric arc between the electrodes is heard. The vibrations produced in this manner are imparted to the wires, and can be viewed, and felt by the fingers.



Mr. Berliner and others, in order to disprove the theory that the microphonic action is produced by a film of rarefied or heated air between the electrodes, placed the latter in a vacuum chamber. It is not necessary for me to describe the result of these experiments; but in this connection I call attention to the experiments of Reitlinger, described in the *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften*, Vienna, A.D. 1862, page 453. The article is entitled "Tones and some Phenomena of Motion Produced in the Closed Circuit of a Galvanic Current." After reviewing the experiments of Paalzow, Forbes, Gore, and others,\* and stating that the electrode of an electrical Trevelyan instrument will rock under water, he describes certain experiments performed in a vacuum chamber with a sheet iron semi-cylindrical rocker resting upon knife-edge bearers. The experiment can be illustrated by the following sketch.

In this experiment it was not necessary to start the

rocking motion by an impulse, the electric current passing across the contact points, produced the rocking motion. Reitlinger, like others before him, attributed the rocking motion to electro-dynamic repulsion, and



C, cross-section, sheet iron rocker.

to disprove the "heated air" theory, he performed the operation in a vacuum. The close analogy to microphone contacts in a vacuum is apparent.

In Poggendorff's *Annalen der Chemie und Physik*, vol. 124, A.D. 1865, Buff describes his experiments on the production of sound by electricity. After referring to prior experiments of Poggendorff, who placed a sheet metal tube, slit lengthwise, around an electro-magnet, and produced tones in the metal cylinder when the edges of the slit were in incomplete contact, and an interrupted current was passed through the electro-magnet. Buff describes his own experiments, which I have illustrated by the sketches below.

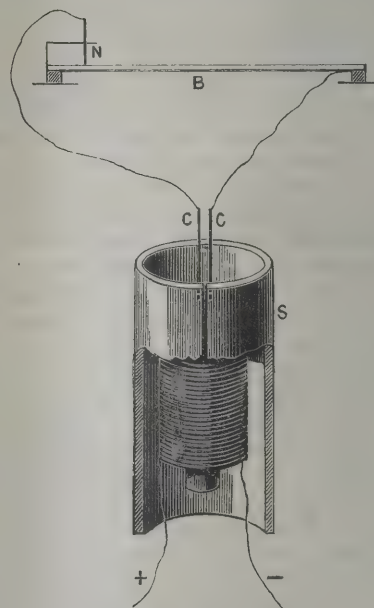


FIG. 1.

N, needle; B, brass plate; C, C, copper wire; S, sheet metal tube slit lengthwise.

In sketch fig. 1. the slit sheet metal cylinder of Poggendorff is used as a transmitter, in which currents are induced by an interior electro-magnet, through which intermittent currents are passed. The receiving instrument is a brass plate, upon which rests a needle electrode that will set the plate in vibration. It is stated that the cause of this vibration is due to "the incomplete contact and consequent increase of resistance at the contact points between the needle and the plate." It is also stated that "when the point of incomplete contact is made of a piece of fine platinum wire, or fine sewing needle, whose *slightly oxidised* point rests upon the plate, then with a current of suitable strength, the point is heated to incandescence, and then when the

\* Reviewed in my former articles.—A. M. T.

current is not too rapidly interrupted a perceptible variation of the incandescence phenomena at the contact points is observed. It is apparent that similar variations, although not visible to the eye, are present when the contact points are not heated so much. If this theory is accepted then the sound produced is due to heat effects at the contact points." Referring to Buff sketch fig. 2, the description which warrants the

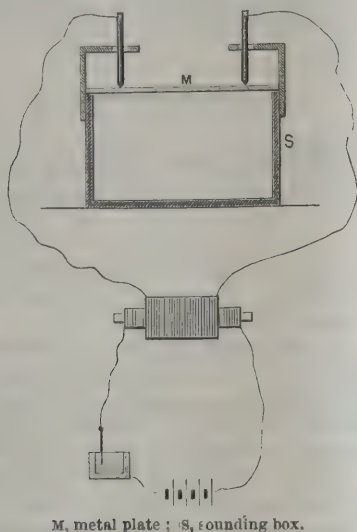


FIG. 2.

same states that a metal plate rests upon a sounding box, and that two needle electrodes bear loosely upon said plate and are connected with the secondary circuit of an induction coil. The primary circuit of this coil contains a circuit breaker which may be either a rotary "make and break," or a mercury cup in which a wire is immersed that is drawn out to break the circuit. In this connection and as having a very pertinent bearing upon the question, as to whether the arrangement with a mercury circuit breaker will not produce a practically continuous induced current, I cite the "Archives de l'Electricite," vol. 5, A.D. 1845, p. 222, in which De La Rive in his article on the production of musical sounds by intermittent currents, says: "A mercury rheotome produces more sustained sounds and slighter shocks, since by the same the interruption of the current is more gradual and not sudden as with a toothed wheel, this being due to the fact that the slight amount of mercury which always adheres to and goes out with the needle when the latter is drawn out of the mercury." In this connection I also cite "Etude sur la Téléphonie," by Dr. Rothen, Berne, 1884, page 93, where Prof. Hughes is quoted as saying that in the reversibility of the microphone (as receiver) the vibration of the diaphragm is in consequence of the variations of the temperature at the point of contact, and that the expansion and recession of the material (contact) produces blows against the diaphragm, and hence causes the same to vibrate. Those who are familiar with the French microphone of Pollard and Garnier, will readily perceive that the "microphone receiver" of Buff closely resembles the same, since both have sliding rod shaped electrodes resting loosely upon a diaphragm. Before closing my review of references which, in my opinion, deprive the *instrumentalities* used in the modern microphone almost, if not entirely, of all novelty, I wish to call attention to a newly published fact that I have discovered concerning the Reis telephone. In the *Annales Telegraphiques*, Vol. VII., A.D. 1864, page 592, it is stated that "the telephone of Reis would be an admirable instrument if it realised in a perfect manner the hopes of the theory. Without prejudging the future, it is well to recognise that it is not yet perfect. When the gamut is produced at the transmitter it takes a well trained ear in order to recognise the sounds in the midst of the vibrations (tremblements) to which it is subjected. Besides this, the model instru-

ment of which we speak is exposed to several causes of error, since the membrane will, at certain moments, not vibrate with the same amplitude, thus occasioning at times want of contact. If the sound emitted rests *within* neighbouring limits *the contact is prolonged*. This inconvenience is avoided by substituting for the voice of the operator a tuning fork furnished with a vibrator (système trembleur), then the note is more precise, although always very weak.

It is not my intention to detract from the merit of the discovery that the loose contact electrodes of Mousson, Rollman, and others, can be set into vibration by the human voice, and thus used for the transmission of speech, the object of the present article being mainly to show that almost all the theories advanced concerning the operation of microphonic contacts were known many years ago, and, as at present, there were men at that time adherents of the "repulsion," "heated air," "arc," and "condensed air" theories. As I stated at the commencement of my present article, the microphone did not require the discovery of the principle that light electrodes placed in loose contact will, by a change of position, or the diminution and increase of the contact surfaces, serve to effect a change in the tension of a current flowing across said contacts. This phenomena was carefully studied by Prof. Mousson, and it only remained for Prof. Hughes to select a known form of variable contact rheostat, just as Bell and Gray used a liquid rheostat in their original experiments. A mercury rheostat, it may be added, was also used in Prof. Mousson's experiments, and he considered the same the equivalent of solid metal bodies placed in loose contact one upon the other.

## ELECTRIC LIGHTING IN MINES AND DAMP SITUATIONS.

WITH the object of overcoming the difficulties which are met with in preserving the insulation at switches, cut-outs, or lamps in the tunnels and workings of mines, Mr. R. Oliver G. Drummond, electrical engineer to The De Beer's Consolidated Mines, Limited, of Kimberley, South Africa, has designed the following fittings:—

The switches\* (fig. 1) and fuses are mounted on spe-

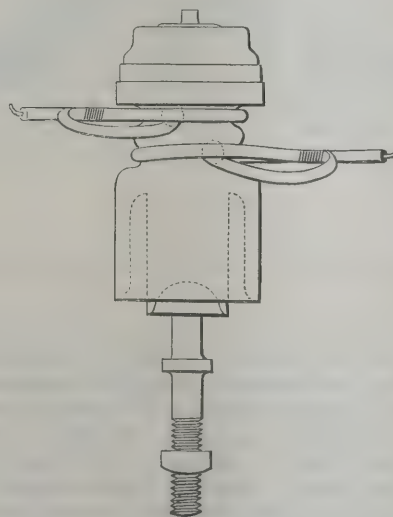


FIG. 1.

cially designed bases, insulated from the bolt that secures them to the timber or roof, and fitted with a cover to keep off the dust, &c., and to protect the workmen from shocks. The wires are drawn in from the

\* The arrangement of the switch seems liable to allow dripping moisture to percolate between the switch turn and the opening in the cover through which it passes.—EDS. ELEC. REV.

lower side of the base, and consequently the dripping water cannot run up the lead into the switch or the fuse. With these fittings there cannot be any appreciable leakage, except where there is a large amount of moisture in the air and consequent condensation on the sides of the insulated bases.

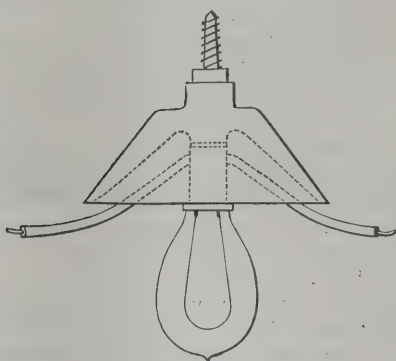


FIG. 2.

The lamps are suspended from a holder (fig. 2) fitted inside a porcelain insulator, which is of such a shape that it becomes a reflector to the lamp, throwing the light downwards, and the heat of the lamp rising into this insulator keeps it warm and dry, no matter how full of moisture the air is. Any water dripping on to it from the roof runs off the outside of it, so that the lamps and holders are thoroughly insulated; and faults from bad insulation are impossible. The bracket lamp is designed of a shape suitable for fixing to the sides of the tunnel, and is fitted in an insulator with the same results as the hanging lamp. The reflector in this case is of such a shape that the light is thrown upwards, downwards, and sideways.

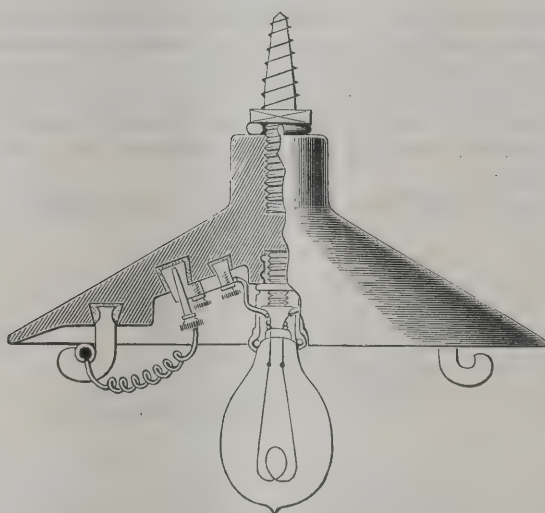


FIG. 3.

When it is necessary to hang lamps in very wet places, the combination fitting (fig. 3) is recommended, as the switch and cut-outs are arranged inside the reflector or porcelain insulator, and as will be seen the heat of the lamp is utilised to keep the insulation of these fittings good. The two hooks are used to suspend the conductors, and as the joint for the branches to the lamps are taken from here, the insulation of these joints is kept good by the warm air rising from the lamp. This fitting has many advantages in rock tunnels, or places where it is necessary to suspend the wires from the roof by insulators, and where there is no timber to attach the wires, lamps, cut-outs, or switches to, and consequently holes have to be bored in the rock, and wooden plugs driven in them. In these tunnels it is generally expensive to bore holes in the roof, as the rock is very hard, and the re-

quired position of the holes is the most difficult for boring, so that the less there are the better. For these reasons the combination fitting was arranged to carry as much as possible. It takes the place of a bracket for two insulators, a support of one switch, two cut-outs, and a lamp-holder, thus one hole suffices for five. The fitting is, moreover, very efficient, as the heat of the lamp is utilised to keep all the necessary parts in connection with the lamp dry, and also the joints and branches from the main wire. The fittings, we may mention, are manufactured by The Electrical Engineering Corporation.

### SOUTH AUSTRALIAN POSTAL AND TELEGRAPH CONFERENCE.

THE following are the principal resolutions, with reference to telegraph matters, carried at the conference held in Adelaide during May, 1890:—

1. That the following terms for reduction of cable rates, as proposed by the Eastern Extension Telegraph Company, be accepted, namely:—"Firstly, the tariff will be reduced to 4s. for ordinary messages, 3s. 6d. for Government messages, and 1s. 10d. for press messages during one year of trial. If at the end of the first year no very serious loss is involved, the experiment will be continued for two years more, and such extension must be at the option of the company. If the loss should be nearly recovered at the end of the three years, the arrangement will be extended for the remainder of the subsidy. The whole proposal is conditional upon South Australia accepting 5d.—the transit rate." (Queensland dissented.)

"2. That in the event of South Australia reducing the telegraph rates on the trans-continental line, in accordance with any resolution agreed to by this conference, the several colonies represented at this conference, including South Australia, agree on the basis of population to guarantee to South Australia a revenue from the line equivalent to that received at present." (Queensland dissented.)

"3. That any colony or country not joining in the contribution to subsidy and guarantee, shall pay proportionately higher rates."

"4. That it be a recommendation to the various Governments represented at this conference. 1. That between any two contiguous colonies 1s. shall be the initial charge for twelve words, and 1½d. for each additional word; names and addresses to be paid for. 2. Between any three colonies 1s. 6d. to be the minimum charge for twelve words, and 2d. for each additional word. 3. Between Queensland and Western Australia 2s. to be the minimum charge for twelve words, and 3d. for every extra word. 4. Tasmania to be a minimum rate of 6d. for twelve words for each colony, plus the cable rates. Twelve words to be considered the minimum rate. Addresses and signatures to be paid for, and code addresses to be prohibited. 5. That the reduced rates come into operation on January 1st, 1891."

"5. That it is considered desirable to adopt a system of urgent telegrams, at double rates, locally and inter-colonially."

"6. That the Uniform Intercolonial Telegraph Regulations, as drawn by heads of departments, be adopted."

"7. That in the opinion of this conference it is very desirable that the heads of the Post and Telegraph Departments of the Australian colonies should frequently meet—annually, if possible—to consider and report to their respective Governments on all questions affecting the postal and telegraphic services generally."

"8. That the President forward to His Excellency the Governor of South Australia a copy of the resolutions agreed to by the conference regarding the reduction of postal and cable rates to the United Kingdom, requesting that his Excellency will forward it to the

British Government by cable, with the expression of the earnest desire of this conference that, as England is equally interested with the colonies in securing and maintaining cheap telegraphic communication, the proposal of the conference that Great Britain should contribute towards the subsidies and guarantees required may be accepted by the Imperial Government."

"9. That the President inform the Agent-General of South Australia of the acceptance by the conference of the amended offer of the Eastern Extension Cable Company, and request him to confer with the Agents-General of the several colonies represented at this conference in order that they may jointly urge upon the Imperial Government their acceptance of the proposal that England should contribute one-half of the subsidies and guarantees required in order to secure the reduced rates agreed to for telegraphic communication between England and the colonies of Australasia."

The colonies represented at the conference were New South Wales, Victoria, South Australia, Queensland, and Tasmania.

### SOME NOTES ON GUTTA-PERCHA.

THE *Annales Télégraphiques* in its September-October issue, contains an interesting communication on the gutta-percha tree. We reproduce some portion of this article.

The word *gutta* (*guetah* or *gueutta*) in the Malayan language means, in a general sense, gum or birdlime, something sticky. The word *percha* or *perfia* means a rag or a strip of cloth, and describes accurately enough the appearance of those gums which, previous to their treatment in hot water, are not unlike rags pressed, and in a partly pasty condition. The idea that *percha* or *perfia* signified *Sumatra* is an error participated in, till lately, by all travellers.

The existence of gutta-percha was made known to the civilised world in 1842 by Montgomerie, the claims of the explorer Tradescant to priority of discovery not being established. The first specimens were brought to London from Singapore in 1843 by José d'Almeida, and the remarkable properties of these gums were speedily made known by Hancock. To Wheatstone must be given the credit of seeking to employ gutta-percha in the insulation of telegraph conductors, but Walker in 1849 in the Channel cable first attempted a practical application.

Since that date many experiments have been made with the view of discovering a substitute for gutta-percha, which is daily becoming more difficult to find, and more costly; in submarine telegraphy the best quality can only be employed, and all attempts up to the present have failed to replace it. The gum of the African *Bassia Parkii* and of the Guiana *Mimusops Balata* have only given negative results; as to the *Payena Leerii* it is used, and to a considerable extent, for the adulteration, in the forests, of the better gums.

The only gums which are suitable for use as insulating material in submarine cables are obtained from the trees of the species *Isonandra*. These plants, which are treated by many botanists as belonging to the species *Palaguium* or *Dichopsis* in the desire to establish a finer distinction, have their natural and exclusive habitat in the Malay archipelago. The extirpation of this species in Malaysian forests proceeds with rapid strides; the natives in cutting down every tree at all productive, and pursuing the same course with the second growth, that is to say, preventing the plants from attaining their full development, have during the last 40 years completely destroyed any possibility of reproduction and multiplication.

The gums, such as were employed in early days for industrial purposes, are now only found occasionally; those which have replaced them will follow the same fate before another 15 years have elapsed. Exportations from Malaysian ports are rapidly diminishing. The inadequate plantations created in the Dutch East

Indies are principally composed, not of the better classes, but of those producing the most abundant sap, that is to say, of inferior varieties. Submarine telegraphy is on the point of finding itself deprived of the species indispensable to it in its operations and extensions.

In chronological order the plant first made known as being the source of a gutta-percha was the *Isonandra Gutta* of Hooker. This tree, the only one whose coagulated sap (sent to Europe at the same time as were the specimens of the plant) has met with practical success, has remained but imperfectly described. It is treated as a species extinct, since 1857, in the island of Singapore, and as existing only in Malaysian forests. As a matter of fact, it has become exceedingly rare, but it is yet to be met with; its fully grown representatives were still to be found in 1887 on the Chasseriau Estate situated in the ancient forest of Boukett Timah (hill of tin) in the centre of Singapore, where the tree was discovered by the botanist Thomas Lobb in 1847. When the plant was again met with in Singapore in 1887, all collecting had there ceased for at least 30 years.

This *Isonandra*, known as the *Isonandra Gutta* of Hooker, the *Dichopsis Gutta* of Bentham and Hooker, and the *Palaguium Gutta* of Baillon, arrives at maturity at the age of 30 years. Its trunk has then a height of from 40 to 44 feet to the lowermost branches, it is cylindrical in shape, and has a circumference of about 3 feet at a height of from 3 to 6 feet from the ground. It flowers every two years after the age of 30. The shape and size of the leaves of the *Isonandra* vary so much, according to the age of the tree and the situation of the leaf, that some confusion has been created in the case of many specimens which have been wrongly assigned to different varieties.

In the Malaysian forests there are only five trees which can be confounded with the *Isonandra Gutta*, partly owing to a kindred foliage, but to a greater degree from the similarity of the saps. No confusion is possible with the other *Isonandra*, which are themselves separated by the *Payena Leerii* (gutta seundek). The guttas seundek, as known in commerce, are nothing but complex mixtures.

The author of the article, M. Sérullas, differs in some measure from the conclusions arrived at by M. Seligman-Lui, who it will be remembered visited the percha producing districts of the Eastern Coast of Sumatra, in 1881, on behalf of the French Government. The *Payena Leerii* is quoted by M. Seligman as possessing most valuable properties, whereas M. Sérullas distinctly qualifies it as an inferior variety. The practical value of the Dutch plantations at Buitzenborg (Java) also forms a point of difference; M. Seligman not only attaches great importance to the probable results of this experimental cultivation, but actually describes the operations as being very successful, and the method most efficient.

### THE ARGENTINE-EUROPEAN CABLES.

THE Buenos Ayres press has been of late engaged in a controversy as to the merits and defects of the concession granted to Messrs. Bieckert & Co. for a direct cable between the River Plate and Europe.

It was rumoured, not long since, that the present Government of the Argentine Republic had decided to annul the concession, but more recently it is announced that this statement was incorrect, inasmuch as the concession has been ratified by President Pelligrini and General Racas.

The journals unfavourable to the concession point out that the nation, whose finances are in anything but a flourishing condition, lays upon itself the burden of having to pay a guarantee of 5 per cent., for 20 years, on a capital of 11,000,000 gold dollars, and they draw the attention of their readers to the fact that another association of capitalists had made an unsuccessful attempt to obtain the guarantee of 5 per cent., for 10 years only, and on a capital of only 9,000,000 gold dollars. For

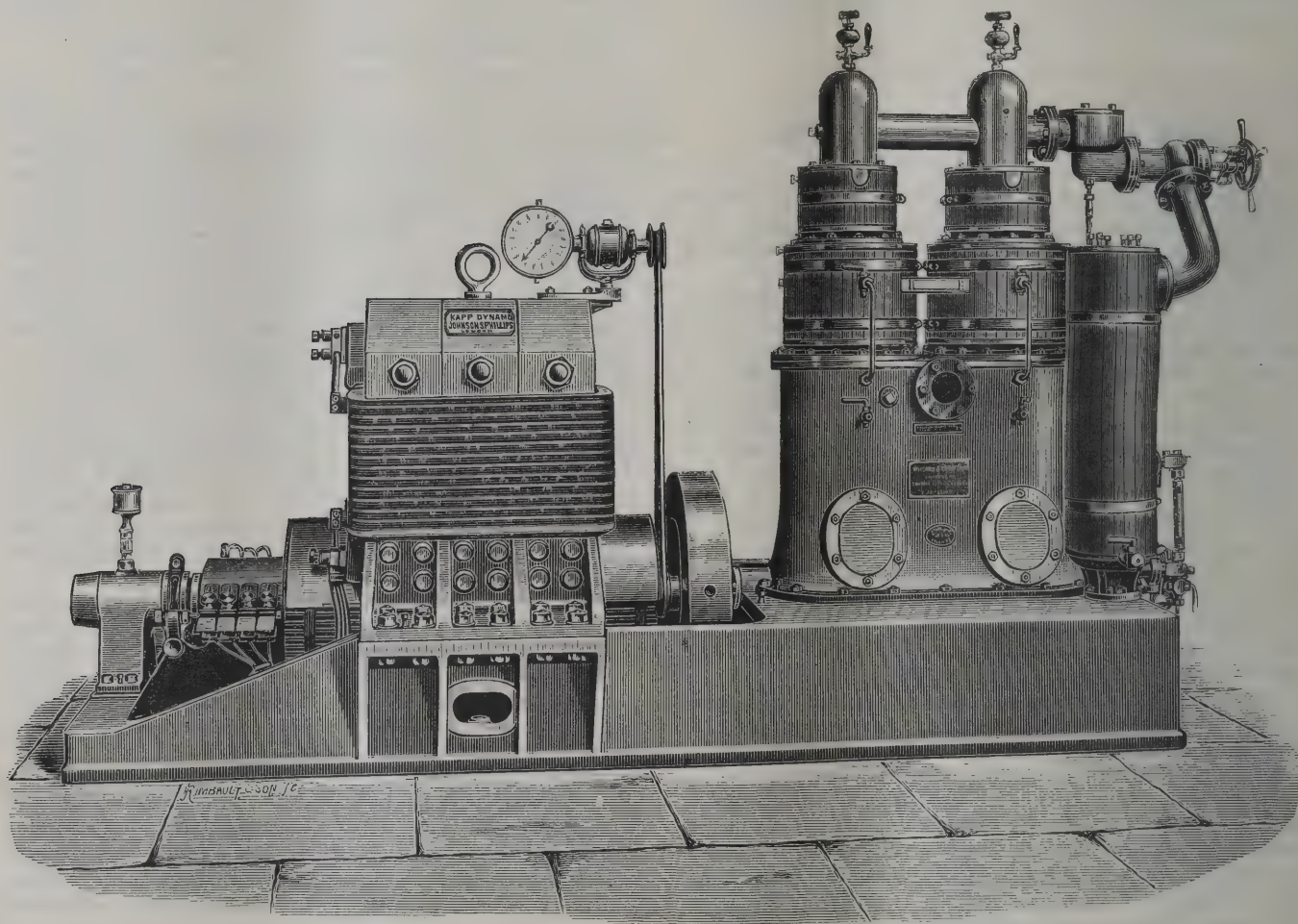
this reason, and also on account of the rumours and suspicious current as to the part played in the transactions by certain high functionaries, it would have been more seemly, say these journals, had the Government entered into a careful investigation of the circumstances under which the concession was originally granted.

Attention is also called, as a motive for deprecating any assistance on the part of the Government towards the laying of new cables, to the very ample telegraphic communication existing between the River Plate and Europe, more than sufficient, indeed, for the requirements of the country. On the east coast of South America, in addition to the cables of the Western and Brazilian Company, which it is expected will be shortly duplicated, two land lines connect Monte Video with Pernambuco. This point is joined to Europe by the Brazilian Submarine Company's cables, and another cable route *via* the West Indies and the United States,

paid by the Brazilian Submarine Company during the last few years are quoted as follow : 1881 to 1882, 7 per cent. ; 1882 to 1886, 6 per cent. ; 1886 to 1888, 7 per cent. ; and 1888 to 1889, 7½ per cent.

### ELECTRICITY AND MINING.

IN the course of his inaugural address—on coal mining—delivered before the Manchester Geological Society last week, Mr. J. S. Burrows, F.G.S., referred to the subject of the lighting of mines. He had but little to say regarding the electric lighting of mines beyond the use of primary and secondary battery lamps, neither of which he at present considered to be a success. The President's address was followed by a speech made by Mr. Merivale, who could "conceive of a time when



WILLANS-KAPP STEAM DYNAMO.

is about to be established. On the West Coast of the Continent, communication with the United States *via* Galveston is obtained through the Transandine land lines, the West Coast of America Company's and the Central and South American Company's cables. The latter company is now actually engaged in laying duplicate cables between Valparaiso and Lima, so as to accelerate the transmission of through telegrams.

The journals favouring the action of the Government in granting the concession insist upon the value to the Argentine Republic of an independent and direct communication with Europe at a low tariff. Such a scheme would possess the additional advantage of avoiding the territories now connected by the existing system. At the present tariffs, it is intimated that there is an annual exchange of over a million words between the Argentine Republic and Europe, and it is calculated that the low tariffs to be charged on the new cable will materially increase this quantity. To lend the scheme a more captivating appearance, the dividends

electricity would be carried throughout the workings of a colliery, both to give light and supply power." Before electricity could be applied to this extent, many difficulties would have to be overcome, such as sparking at the brushes. He referred to the few instances of the application of electricity to mining operations in this country, and believed that this agent would in time "revolutionise both their defective means of lighting and their old-fashioned plan of getting coal by hand labour." Sparking at the brushes was, however, his bugbear; but this difficulty, as is well known, has already been overcome in many machines on the market, whether running at full or less than full load.

The dual subject raised by the two speakers is one which is gradually being brought into greater prominence among mining engineers and mine owners in this country. Portable electric lamps of the primary and secondary battery types will probably come into use in time, but owing to their high price and inconvenience of recharging, it is fair to assume that they

will not be extensively employed. It appears more probable that the electric lighting of mines will be conducted on similar principles to those adopted in private installation work, that is to say, the generating plant will be suitably installed and the lamps placed along the roadways, whilst portable lamps will be used where the leads have not to be carried. In this connection it is interesting to note that the Fife Coal Company have announced their intention of introducing the electric light in their pits at Leven, the lamps to be placed 15 yards apart along the roads.

The application of electricity for pumping and hauling purposes at St. John's Colliery, Normanton, in the Forest of Dean for pumping, at Llanerch Colliery for pumping and hauling, and at Llanlithgow for pumping purposes, has shown by actual working results that electricity is more economical than compressed air or steam plant. Electric coal cutters were "demonstrated" some three or four years ago, but, beyond this, nothing seems to have been heard of these machines. We are informed, however, that an English firm has supplied electric coal cutters for nearly four years, and that the plant is running successfully. At present, details regarding these machines are for obvious reasons withheld, but practical working data will in the course of a few months be forthcoming, when the subject will be brought before the notice of the engineering world.

TRIALS OF A WILLANS-KAPP STEAM  
DYNAMO.

WE give the result of the economy trial of a Willans-Kapp steam dynamo which Messrs. Johnson and Phillips have built for the Birmingham General Post Office.

[COPY.]

CONSUMPTION TRIAL.—No. 982.

Engine. No. 982. For Birmingham P. O. Barometer 30.3 falling. Dy. No. 83. Date August 8th, 1890. Present, Mr. Low.

Water collected.		100 lbs. interval.	Ampères.	Volts.	Remarks.
Weight in lbs.	Time.				
	hrs. mins. secs.	mins. secs.			
4420	3 36 15	...	450	Volts constant at 112 throughout run.	Voltmeter, Ever-shed, 436, checked by small S. dynamo. Ammeter Siemens = 2477.
4520	3 39 34	3 19	452		
4620	3 43 53	3 19	440		
4720	3 46 13	3 20	448		
4820	3 49 34	3 21	454		
...	...	...	440		
5020	3 56 11	3 18.5 (2)	443		
5120	3 59 34	3 22	450		
5220	4 2 50	3 16	452		
...	...	...	448		
5420	4 9 31	3 20.5 (2)	450	Volts constant at 112 throughout run.	
5520	4 13 46	3 15	456		
...	...	...	450		
5720	4 19 20	3 17 (2)	452		
...	...	...	438		
5920	4 26 9	3 39.5 (2)	438		
6020	...	...	440		
6120	4 32 49	3 20 (2)	450		
1700	0 56 34	...	...	112	Kilowatts 50.2
		Mean ...	447.2		

Indicated H.P. = 79.7. Electrical H.P. = 67.4. Commercial efficiency = 84.6 per cent. Total water per hour, including escape from jet cocks, 1,807 lbs. 27 lbs. of steam per E.H.P. hour.

New Electric Construction Works at Wolverhampton.—The new electrical construction works at Bushbury, on the north side of Wolverhampton, will be ready for occupation before Christmas, and will give employment to some 1,500 hands. The company has sufficient contracts on hand to keep the works in active operation for some time to come.

NOTES ON CENTRAL STATION ELECTRIC  
LIGHTING.\*

By CHARLES H. YEAMAN, Assoc. Inst. E.E., Stud. Inst. C.E.,  
City Electrical Engineer, Liverpool.

At various times the industrial applications of electricity have occupied the attention of this Society; and of these, the most taking has without doubt been the calorific or thermal effects of the current practically used in the arc and incandescent lamps. In March, 1885, a paper was read on "Electric Lighting from Central Stations," drawing attention to the American and English stations then supplying current, and blaming the Electric Lighting Act of 1882 for the tardy development of the heavy electrical industries, and more especially that of the public supply of electricity.

Since the date of that paper, the Amendment Act of 1888 has been passed, and the first fruits of its lightening of the burdens borne by the craft of electrical engineers are to be seen far and wide. The difficulties which had previously beset the use of electricity in this country had taken the shapes of mad speculation and legislative restriction. The lessening of these difficulties has removed most of the impediments to the extension of electrical works. That this is the case, is proved by the number of central stations projected and in use all over the kingdom, in connection with schemes which have sprung into being since the passing of the 1888 Act. The present position of the industry, technically, is one of friendly antagonism between the devotees of some half-dozen systems, any one of which would probably, in competent and experienced hands, prove successful, and each has certain advantages and disadvantages compared with its rivals.

The problem of a commercial supply of electrical energy throughout an extended area directed attention to the question of the pressure or voltage to be employed. The lamps at present on the market do not allow of any very great choice in this respect, the lowest pressure for a 16 C.P. incandescent lamp being about 50 volts, and the highest a little more than double that value.

There are special types of lamps to be had of somewhat lower and higher voltages, but, generally, they do not give satisfaction; and, as standard pressures for the lamp circuits are generally adopted, and as the price of the lamp is its chief drawback, any great multiplication of standards is to be deprecated. The Brush Company prefer 60 volts, Sir William Thomson advocates 80, The Metropolitan and London Electric Supply Companies and Messrs. Crompton usually specify 100, and here in Liverpool 110 volts is maintained on the canalisation. The Westinghouse Company, of America, have adopted 50 volts for their lamp circuits, and it is understood that the Sardinia Street Station of the Metropolitan Company, in London, run on this system, has also taken the American practice as its basis.

For isolated plants, where the dynamo was only, at the most, a few dozen yards from the lamps, a simple parallel low tension supply satisfied all requirements, and was both economical and sufficiently elastic in working to make any elaborate regulating arrangements unnecessary. As the distance to which the current had to be transmitted was increased, it was found that either the network of mains required to be large, unwieldy and costly; or that the loss in pressure was excessive, and that lamps of different voltages were required to compensate for the variations in voltage as the distance from the supply increased. On the simple tree system of working, it was impossible to keep within anything like the limits of the variation permissible by the Board of Trade Rules, and the system of feeders and feeding points, as proposed by Edison, was used where possible. On a low-tension network properly laid out, aided by feeders, it is commercially possible to work within a radius of a quarter of a mile from the station, and carry out all the regulations under law as to the maximum pressure and the allowable variation.

As at this point it might be expected something should be said regarding Liverpool electric lighting, the writer would only soothe the fears of those who dread shocks, by assuring them that there is, in the system at work in this city, no possibility of personal danger, and that the danger of fire has been very efficiently guarded against. As Messrs. Holmes & Vaudrey, the engineers of the company, are members of this society, it is not desirable to trench upon anything they might wish to say in the future about their own work, and as one can always gain information about the Liverpool work by personal enquiry, it is proposed to look further afield for stations to be discussed.

One of the first difficulties that the supply companies had to grapple with, was the small encouragement given them to lay underground mains, and they were compelled, if they intended to supply at all, to go overhead, so much were they opposed on attempting to break up the public streets. Of course it was quite out of the question to run heavy circuits of copper strap or large cable aerially, and some method had to be thought of, by which to supply customers at great distances, and with a fairly large quantity of the commodity called "Electricity," which, be it noted *en passant*, requires to be defined, if one is to use it generally. Electricity to the public means energy, to the technologist it denotes current, a very different thing. The thing the public want, and which they are quite willing to pay for, and handsomely

\* Paper read before the Liverpool Engineering Society, January 29th, 1890.

too, is electrical energy; this is not simply current, but the value found by multiplying the numeric of the current by that of the pressure in case of a current flow in one direction or uni-ward, but which is, with alternating or periodic currents, equal to  $\sqrt{f \cdot e^2} \times \sqrt{f \cdot c^2 \cos k^0}$ , the square root of the mean square of the electromotive force, multiplied by the square root of the mean square of the current, multiplied by the cosine of the angle of lag between the impressed E.M.F. and the resulting current.

Since the aerial cables must be kept of moderate size, and it is well known that the carrying capacity of a cable is limited to a certain number of ampères, or a certain current, quite independent of the pressure under which that current flows, and the energy—that which is desired to be transmitted—is proportional to the product of the two factors, an attempt was made lately, and successfully, to increase the voltage under which the current flows, thus decreasing its volume with a given output of energy, and enabling a smaller size of cable or weight of copper to carry a supply of electrical energy a given distance with a given loss, than would be required with the pressure used up till that time. Regarding the loss in transmission, it must be remembered that the loss is a loss of head or pressure, and that it is analogous to that in a pipe, where the friction reduces the available head so many feet per hundred yards per rate of flow. The point where the analogy fails is the fact that friction has not a numeric as if it were a physical quantity like mass or specific heat. The question of high tension electric supply is very much like the problem solved by Mr. Ellington, in his power distribution scheme by high pressure water. Since by doubling the pressure we quarter the area of the conductor, or what is the same thing, reduce its weight per unit length to one-fourth, it will be seen that with a given loss per cent., the weight of copper required to transmit a given quantity of energy, a given length is inversely as the square of the volts employed. That this is so may be easily seen, if it be kept in mind that the loss in distribution is proportional to the current density in the conductor. Let  $c$  represent the current and  $e$  the voltage at which that current is to be distributed, then  $c \times e$  represents the total energy; and, if  $R$  be the resistance of the copper core, the loss will be  $c^2 R$  watts; therefore, the percentage loss will be

$$\frac{c^2 R}{c \times e} \times 100$$

If  $c \times e$  watts be distributed at double the first pressure, or  $2e$ ; the current will be reduced to  $\frac{c}{2}$ ; and, if the loss is to remain at its previous value,  $c^2 R$  must now be  $(\frac{c}{2})^2 4R$ , and the percentage loss becomes

$$\frac{(\frac{c}{2})^2 4R}{c \times e} \times 100; \text{ i.e.,}$$

the weight of copper required has been reduced to one-fourth, with the same loss. Therefore, with overhead conductors, two things are gained by using high tension. (1.) A lighter conductor to transmit a given quantity of energy; and, (2.) A smaller per cent. loss with given density of current.

As has already been pointed out, high pressure cannot exist across the terminals of a lamp, and therefore some appliance, called a transformer, secondary generator, or converter, must be inserted to deliver the energy of the high tension electric supply to the lamp at the voltage for which it is intended. The general theoretical law of these transformers may be thus expressed:—

let  $e$  = Primary H.T. E.M.F. in volts.  
 $c$  = " " " Current in ampères.  
 $E$  = Secondary L.T., E.M.F. in volts.  
 $C$  = " " " Current in ampères.

then  $e \cdot c = E \cdot C$ , or the energy of the two sides of the apparatus should numerically equate. This it never does, but the efficiency or energy got out i.e.,  $\left(\frac{E \times C}{e \times c}\right) \times 100$ , may at full load be 95.

In Mr. Vaudrey's paper, read before this Society in 1887, the question of electrical energy and its factors is fully dealt with.

The relative values of the two factors, the product of which, multiplied by time, gives the work done, may be varied as desired, and herein lies the beauty of all transforming systems. The primary circuit may be common to several transformers, and yet the secondary circuits may give any voltage, and any current desired; in fact, they may even work at a greater power than the primary circuit possesses.

The power of an electric circuit is expressed in watts, and the watts = energy expressed mechanically, or  $c \times e$ . The work =  $c \times e \times \text{time}$ .

The principal disadvantages of transforming systems are—

(1.) Low percentage duty.

$$\text{Per cent. duty} = \frac{c \times E \times \text{time}}{e \times c \times \text{time}} \times 100$$

(2.) Low percentage efficiency at low power, i.e., when not up to full load.

$$\text{Per cent. efficiency} = \frac{\text{watts got out}}{\text{watts put in}} \times 100$$

$$\text{or} = \frac{c \times E}{e \times c} \times 100$$

(3.) The high tension is dangerous to life. There can be no gainsaying the fact that personal safety is jeopardised by excessive

pressure. There is the greater tendency to leakage to earth, and its attendant difficulties and dangers which are clearly foreshadowed in the Board of Trade regulations.

(4.) There is the dependance of a sub-district or area of lighting on a single piece of apparatus, and the insertion of another chance of failure between the dynamo and the lamps.

The transformers may be of various kinds.

- A. Continuous current transformers.
- B. Alternating current transformers.
1. Storage or battery transformers.
2. Non-storage or magnetic transformers.

These latter may again be divided into—

- a Moving or dynamotors.
- b Fixed or molecular.

All of the 1 class are at present A. All of the B class are at present b, those of a type have not found much favour, and are used principally in conjunction with those of class 1: they are therefore continuous.

The alternating current molecular transformer has by far the most extended application at the present time, and if the balance sheets of the stations under that system will bear perusal, it bids fair to hold its own with all the other systems combined.

To obtain the advantage of high pressure, transformers may be coupled in two ways like other electrical apparatus:—

- C. In series, like arc lamps, constant current system;
- D. In parallel, like glow lamps, constant potential system.

Alternating molecular transformers are usually coupled. D system and battery or chemical transformers in the C system. This is based upon reasons of simplicity rather than anything else, as it is a simple matter to obtain a constant current continuous, but hardly possible alternating, and because the effect of induction does not militate against a single wire carrying a continuous current, but a single wire through which an alternating current was flowing, would render telegraphy and telephony almost impossible for some distance around.

The cost of the generators in the two transformer systems is about the same, and any possible difference in this item will have but a very small effect on the total cost, of which it becomes a very small factor. The low pressure of the ordinary parallel system, the perfect protection from excessive current obtained by the safety devices in use, and the continuous character of its current, render it practically inert so far as its effect upon existing property is concerned. That the alternating system, with its strong inductive influence, will occasionally cause trouble to existing telegraph and especially telephone lines, seems inevitable.

The chief advantage with the battery transformer system is, that it is possible to spread the work of the engines over as long a period, within the 24 hours, as may be found convenient, so as at all times to work the engines at full power. When, on the other hand, the supply is taken direct from the machines, the engines must, at each moment, develop whatever power may be then under demand. It is well known that, with modern compound or triple-expansion engines, such as could be most advantageously used for central station work, the coal consumption rises very rapidly per indicated horse-power, as the output is diminished. This becomes a most serious consideration, when the maximum demand bears an undue relation to the mean. In many cases the maximum demand is five or six times the mean daily average, and lasts only half an hour or so.

Methods adopted in central station lighting:—

1. Series system with battery transformers. Example: Chelsea.
2. Series-parallel system. Example: Hastings.
3. Three wire system. Example: St. James's and Pall Mall, London.
4. Parallel system with batteries. Example: Kensington Court.
5. Alternating transformer system. Examples: West Brompton—Lowrie Hall system. Glasgow—Ferranti system. Bournemouth—Morley system.

#### 1.—SERIES SYSTEM WITH BATTERY TRANSFORMERS.

Example: Chelsea.

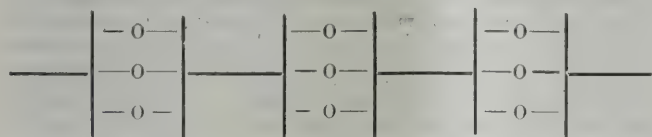
Following the order of the list of stations, Chelsea, with its stations for generating and distributing on the "King" system, first demands attention. The whole of the regulating and supply mechanism is automatic, the changing of the various battery stations in series alone being dependent on human energy and foresight, the system is extremely simple to work, but very complicated in erection, and it is doubtful if such a mass of interlocked automatic appliances is desirable, or if its life will be what is fondly hoped for. The system is an elaboration of the Beeman, Taylor and King station, which was laid down in Colchester in 1884, and of which a full account is contained in Mr. Fleming's paper of March, 1885, so that the description need not be repeated. The present plant, generating and distributing, and method of working, has been made public in a very complete and valuable paper, read by Major-General Webber, before the Newcastle-on-Tyne meeting of the British Association, in September of last year, and as nothing in the space available here could do justice to the subject, the writer begs to refer those interested to that paper.

#### 2.—SERIES-PARALLEL SYSTEM.

Example: Hastings.

The use of transformers in a high tension circuit is to allow of flexibility and remove any restrictions to supply that otherwise

would be imposed on the consumer. Hastings is an example of a high tension system without transformers, which has been working most successfully since 1881, and is now supplying over 1,000 incandescent lamps of 8 C.P. and 30 volts, the lamps being grouped in parallels of 16. This station, prior to the introduction of transformers, constituted the most successful instance of long distance distribution, not merely in this country, but anywhere. Brighton started also as a series-parallel supply, but has lately been altered to Lowrie Hall alternators. The principal feature which strikes one at Hastings is the extreme simplicity of the generating plant. The motive power consists of two 40 H.P. Robey engines and boilers, the engines being belted on to a counter-shaft rather below the level of the dynamo platform, and from which the five "Brush" constant current dynamos are driven by endless belts. These machines give 2,000 volts and 10 ampères. One is reserved as a standby, one is used for the arc lamps on the parade, the 30 arcs of 2,000 C.P. loading the machine fairly well up. The glow lamps are used in hotels and private residences, and these machines are run on the same number of separate circuits. The current flowing is proportional to that required by each lamp, multiplied by the number of lamps in parallel, and the pressure is equal to that required by one lamp, multiplied by the number of groups in series.



C = Current for one lamp.

E = E.M.F. " " "

N = Number of lamps in parallel.

M = " " groups in series.

F = E.M.

C = C.N.

C = Total E.M.F.

E = Total current.

The principal objection to a constant current supply is the fact that individual lamps of a group are dependent on their neighbours of the group, and no economy results unless the group of 16 lamps are turned off.

There are in Hastings underground circuits aggregating 20 miles of single wire,  $\frac{7}{16}$  strand, double G.P. and braided, drawn into 4-inch cast-iron pipes, with test boxes every 100 yards. The terminal pressure of the dynamo is regulated by a Brush carbon regulator, which maintains the current constant at 10 ampères, and in the supply circuit is placed an Ayrtton and Perry ammeter. The general method is to make a fixed charge per annum, which is settled by agreement.

The machines at Hastings are simple arc lighters, and give a current of 10 ampères suitable for arc lamps; they are used for incandescent lighting by grouping a number of incandescent lamps in parallel, so that they absorb the 10 ampères, and these groups are then treated as single arcs might be by being placed in series, i.e., one after the other.

### 3. THREE-WIRE SYSTEM. PARALLEL SERIES.

Example : St. James and Pall Mall, London.

The three-wire system is one attempting to do away with the inter-dependence of the individual lamps, and does not involve transformers, while it retains to a great extent the advantages of high pressure. In this system the number of lamps in series is reduced to two, and the groups in parallel are increased. Edison in America, and Hopkinson in England, have improved and perfected the system, allowing each lamp lighted to be quite uninfluenced by the number of lamps alight elsewhere on the circuit. The practice is now to run two dynamos of equal output—and voltage in series—and between the positive (+) of one and the negative (-) of the other, to string the incandescents in series of two. By this means the pressure is double that of the simple parallel system, and the weight of copper required is only one-fourth that of a two-wire network. As, however, the lamps are two in series, turning out one lamp would also extinguish its fellow. To avoid this a neutral wire or equaliser is run from the junction of the two dynamos to the middle connection of the groups of lamps, thus rendering each lamp independent.

The finest example of this method of working is the new station of the Pall Mall and St. James's Company in Mason Yard, Duke Street, St. James, London. The boiler room and dynamo room have been dug out underneath the yard, and a three story fire-proof building of white brick is carried on iron girders and pillars in the centre. The station is laid out for a total capacity of 20,000 16-C.P. lamps. Six Davey-Paxman boilers supply steam to 10 Willans central valve engines, capable of developing 210 H.P. at 350 revolutions, and two smaller ones capable of developing 80 H.P. The engines are mounted on combination bed-plates, upon the other halves of which the field magnets and bearings of the dynamos are supported, the armatures being coupled direct to the engine shafts. The field magnets of the dynamos are vertical, with poles downwards, and supported by brass brackets from the bed-plates. Regulation is effected by inserting resistance into the magnet circuits, which are shunts on the main. The generating sets are arranged in two rows of six each, one on either side of a central gangway towards which all the commutators of the dynamos are directed. The connections from the dynamos pass through suitable regulating and safety appliances before reaching the switchboard from whence the three-wire feeding network is supplied.

The underground system is an air insulated culvert, and the largest main consists of eight strips of copper 2 inches wide by 0.1 inch thick, forming the (+) and (-) leads, while the neutral wire is formed of four strips the same size. The strips are supported by porcelain insulators, and spaced by means of porcelain jockeys, the whole being carried in a cast-iron culvert. This distributing system consists of a complete ring, fed by heavy feeders, and with radial distributors running out beyond the ring. From each feeding point, pilot wires run back to the station, so that the pressure at each point can be ascertained. The pressure on the ring main is kept constant at 107 volts, and houses connected to this main are supplied with 106 volt lamps. Three load diagrams taken towards the end of December, 1889, give evidence of the very high proportion borne by the mean to the maximum demand.

### 4. PARALLEL SYSTEM WITH BATTERIES.

Example : Kensington Court.

This station, laid down by Messrs. Crompton, was the first station in London under the Electric Lighting Act, and has been extremely successful. At present there are two boilers by Marshall, 15 feet long by 4 feet diameter supplying steam to three coupled Willans engines and Crompton dynamos, one capable of lighting 1,600 16-C.P. lamps, and the two smaller 500 lamps, each of 50 watts. The speed of the dynamos is 370 to 400 revolutions per minute, and the consumption of coal 2.5 lbs. E.H.P. per hour. The load in the station at the end of last year was 1,500 lamps, many of these being 8 C.P., the favourite size on the Kensington Court estate, which is supplied at its limits as far as 950 yards from the generating station. The mains consist of bare copper conductor, laid in a brickwork and cemented culvert having a concrete bottom, and running under the footway. The culvert is 18 inches x 5 inches deep, and is divided into two channels by a mid-feather of brickwork in cement, and the whole is covered with flagstones. In the longitudinal channels thus formed, the copper conductors are strained over porcelain insulators, standing on short iron uprights fixed to the bottom of the channel, and the straining is effected by brass shackles, insulated by glass supports. The insulation thus obtained has been very perfect, and no trouble has resulted so far from moisture. A secondary battery of "Howell's" type is used to supply current when the machines are not running, and to aid the dynamos during the excessive discharge, for a short period each evening.

### 5. THE ALTERNATING TRANSFORMER SYSTEM.

Examples : West Brompton, Glasgow and Bournemouth.

The model station on the alternating system is certainly that of the House-to-House Company, Limited, who, basing their designs on what had been done at Brighton, Hastings, and Eastbourne, have overcome some of the difficulties of a commercial supply with a periodic current. Their station at West Brompton, situate as some say between the "quick and the dead," lies between the Metropolitan District Railway and the London and Westminster Cemetery, with a frontage to the Richmond Road. The completed station will contain 12 sets of plant each, capable of supplying 4,000 16-C.P. lamps, the engine and boiler room, offices, workshops, testing rooms, engine and drawing offices, taking up a plot of land, 470 feet x 60 feet. Three of the sets of plant are down; and although powers were only obtained in October last, nearly eight miles of underground mains have been laid, and current is supplied to 7,000 incandescent lamps, increasing by 500 per week on its circuits, and it is running permanently and supplying these by meter. Fowler's horizontal coupled compound engine, of 200 H.P. 30-inch stroke, 88 revolutions per minute, drives by seven cotton ropes,  $1\frac{1}{2}$  inch diameter, from a 14 foot flywheel, a Lowrie-Parker dynamo, with fixed armature and rotating field magnets, capable of maintaining an output of 100 units at a speed of 350 revolutions per minute. The E.M.F. is 2,000 virtual volts, and the periodicity 83. The revolving field magnets are supplied with magnetising current by an exciter driven by four  $\frac{3}{4}$ -inch ropes from the shaft of the alternator. This is a series wound Elwell-Parker continuous current machine giving 8 ampères. All wires are brought underground to the testing room, and are brought up at the back of the switchboard, so that it is impossible to touch the high tension connections. The switchboard is constructed in chinaware mounted on ebonite, and connection between the dynamos and mains is made by insertion of the connecting block with four brass pegs. Any circuit can be connected to any dynamo, and it is impossible to short circuit a machine, by reason of the distance of the brass pegs.

The regulation of the dynamo is effected to within 1 per cent. by means of the Lowrie-Hall regulator, which utilises the thermal effects of the current as a means of maintaining a constant E.M.F. across the terminals of the alternator. A thin wire attached at its extremities and weighted at the centre, is connected across one coil of the armature of the alternator, and by its sag allows a rocking arm to make contact with one or other of two tables connected to the two coils of the variable resistance fixed above the wire chamber. The liquid resistance is in shunt with the field magnets of the exciting dynamo, and by weakening or strengthening its field varies the magnetising current to the alternator, and, therefore, the pressure across its terminals. This current at 2,000 virtual volts is distributed underground by means of lead-covered cables drawn into gas pipes, 3, 4, and 5 inches diameter, with joint boxes at suitable intervals.

The mains are of special make, being Fowler-Waring cables, manufactured under Tatham's and Waring's patents. The insulation

is the highest yet made for cables, being stated as over 3,000 megohms per mile. The insulation consists of fine braidings saturated with a patent solution, and the cable is then lead covered, and has a coating of hemp over all. The cables are made in five standard sizes to supply 2,000, 1,500, 1,000, 500 and 250 10-C.P. lamps at a distance of 1 mile. The largest cable of this make in use is  $\frac{37}{16}$ . These cables are not exclusively used by the House-to-House Company, but have been found the most satisfactory up to the present. It is somewhat curious that lead covered conductors should be found so satisfactory for use, with alternating currents, in this country, as there is a great tendency for a spark to break down the dielectric on account of the induced currents in the lead, and in America elaborate apparatus is inserted to do away with this tendency. The cables were also used to carry the 10,000 volts that Mr. Ferranti proposes to use to convey the electrical energy from Deptford to London, and certainly these have been the only cables which have withstood the voltage employed by the London Electric Supply Corporation for any time, and, though they subsequently developed faults, the tension was phenomenal, and no research has up to the present demonstrated what goes on when an abnormal pressure is employed.

Before reaching the switchboard the current has to pass through a high tension fuse consisting of a long length of fine copper wire. The steam supply to the engines is maintained by six Babcock-Wilcox water-tube boilers, capable of evaporating 5,500 lbs. of water per hour, and requiring not more than 1 lb. of best Welsh coal per 10½ lbs. of water evaporated. Working pressure, 150 lbs. per square inch.

The secondary generators or converters, are coupled in parallel on the high tension circuit, and reduce the pressure from 2,000 virtual volts in the primary, to 100 virtual volts on the secondary, with a corresponding increase in the ampère. The Lowrie-Hall transformer is one of the "core" class, that is, it has two sets of coils and only one core. It is built up of thin iron plates, each plate being separately insulated from the rest to prevent eddy currents. On each of the individual cores a primary and secondary coil is wound, part of the core projecting beyond the coils at both ends. The coils are then placed side by side, and the plates of the projecting cores are turned over alternately, each pair of plates forms a closed magnetic circuit insulated from the rest, and the two individual cores forms one endless magnetic circuit.

One of the principal points in a system of public supply is that of measurement of the quantity of electricity supplied, and this is an especially difficult problem with alternate or periodic currents. Messrs. Lowrie, Hall and Kollé, have succeeded in utilising the principle of Edison's chemical meter for this purpose, by inserting into the lamp circuit an electrolytic vessel, and cell of constant electromotive force, which will therefore add its difference of potential to one phase, and subtract it from the reversed one, thereby creating a difference in the total quantity that has passed round the circuit positively and negatively. The equivalent therefore is obtained of a continuous current of an amount proportional to the number of lamps that are on the circuit, and the quantity of metal lost by one plate and gained by the other measures the total number of lamp hours or Board of Trade units.

#### GLASGOW AND BOURNEMOUTH.

Two other systems of high tension alternate current distribution deserve notice as being like the Lowrie-Hall, complete in themselves from generation to dissipation. These are the Ferranti and the Mordey. Glasgow is favoured by having an overhead network of conductors working at 2,400 virtual volts, and as the station worked by Mavor and Coulson is a typical one, it is interesting to compare it with the others.

The station was laid down on ground acquired by Messrs. Muir, Mavor and Coulson, Limited, in Little Hamilton Street. The engines, boilers, and dynamo are on the ground floor, which has an area of about 1,400 square feet, and the plant at present at work is capable of supplying 1,750 16-C.P. incandescent lamps. By the end of this year it is expected another engine and dynamo will be in working order, doubling the power of production. A loco. type steel boiler supplies them at a pressure of 100 lbs. to the square inch, to which feed water is supplied by a Worthington steam pump capable of delivering 2,000 gallons per hour at a slow speed, a self-starting injector capable of feeding two boilers, and a Berryman feed heater.

The motive power consists of a compound non-condensing horizontal tandem engine of the Putnam type, with tappet and cam valves, with cylinders 14 and 22 in. diameter, by 42 in. stroke, and indicating 200 H.P., at 85 revolutions, the flywheel being 14 feet in diameter. This drives by rope gearing a Ferranti alternator 4 feet in diameter, at 450 revolutions per minute, weighing in all 7 tons, and carrying its own exciter on the armature shaft. The exciter, which is shunt wound, supplies 30 ampères at 95 volts to the field circuit of the alternator. Special arrangements have been made for continuous running, in order to maintain a constant supply day and night. A reservoir of oil with level gauge glass is erected above the machine and supplies a constant service to the bearings, the oil passing then to a reservoir from which it is pumped back again.

The switchboard is a double pole one with means of throwing over the distributors on to the Siemens alternator which has an output of 250 ampères, at 50 virtual volts, and is on Kennedy's plan raised to 2,400 virtual volts by means of a large station transformer (which plan has lately been suggested for Deptford as being safer than having 10,000 volts on the dynamos). The small alternator is driven from an inverted cylinder compound

engine of 50 H.P. by rope, and is used for the supply during the small hours of the morning. The periodicity of the Ferranti current is 67. The facility with which the field magnets can be separated and the armature exposed for examination is a great practical advantage. On the switchboard are fixed two ampère gauges, and an electrostatic voltmeter of Sir Wm. Thomson's design, the gauges being in the high tension circuits, and the voltmeter being across the terminals of the alternator which is coupled to the supply circuits by means of six fuse boxes also mounted on the switchboard, one for each cable of each circuit and three double pole switches. The fuses are made up of lengths of fine copper wire about one foot long, and are fixed in vulcanite supports at each end of an earthenware box, which is made with internal ridges so as to cause the fuse to blow at a number of places at once. These boxes are ordinarily covered by an earthenware lid. From the double pole switches the six cables pass out of the station on porcelain insulators to the circuits.

Of the six overhead circuits, one supplies the Municipal Buildings, and the others radiate out west, north, and eastwards. In the Municipal Buildings 1,100 lamps are in use, and the current is supplied by meter, that of the Aron pattern, being fixed on the circuit to the six transformers coupled to the various lamp circuits inside the building. Generally, however, the Schallenberger meter is used, and is giving satisfaction, probably superseding the Aron, as its accuracy is greater. It consists of a circular iron disc placed on a vertical arbor attached to connecting mechanism, and also carrying a fan to introduce resistance to movement by air friction. The iron disc rotates very freely. Two diameters of this disc are chosen inclined to each other at 45°. A coil of copper ribbon fixed to the case is coiled round each of these diameters; one of these coils is connected with one of the wires going to the lamps, and the other is closed on itself, and the latter has therefore induced currents circulating in it attaining a maximum a quarter of a period later than the main current, that is when the main current is at zero. Thus we have a continuous rotation of the iron disc when an alternating current is flowing in the main coil. It is a very convenient type of meter for alternate currents, the only objection being that its indications vary with the speed of reversals of the alternating current: our best governors are not perfect, and our most reliable suppliers of electricity would be tempted to alter its indications by increasing the speed of the engines a little.

The Aron meter consists of an ordinary clock with a coil of wire for the bob of the pendulum, and below this is fixed a coil of wire, carrying the current going to the lamps. The effect of the current is to diminish the influence of gravity on the pendulum, and thus cause the clock to lose time. The loss of time as compared with a good uninfluenced clock shows the number of units of electricity which has passed through the instrument. The fact that the clocks require to be wound up militates greatly against the general adoption of this meter, and there are several minor objections to it. The Ferranti converters used in Glasgow are of the shell type, with two cores and one coil, and seem to be equally efficient with the Lowrie-Hall. It will be clear that the exact disposition of the coils and core is immaterial so long as the relative position is maintained: that is, a primary electric inducing circuit linked to a secondary induced circuit by means of a magnetic circuit closed through the primary and the secondary.

The system in use at Bournemouth, and lately laid down at Bournevalley, 2½ miles from the town, is that largely brought out by Mr. Mordey. It is generally accepted that transformers, though economical in that the generating station may be a long distance away from the consumers, do not do away with the necessity for a low tension distributing network; and that therefore the system is worked on the principle of one large generating station, and several scattered distributing stations, having large transformers supplying within a radius of something like 200 to 300 yards; and both Mr. Ferranti and Messrs. Lowrie and Hall know this. Mr. Mordey, on the other hand, prefers to allow a transformer to be placed in each consumer's premises, and his system is designed to admit of the greatest flexibility in this respect.

The Bournemouth station is built on a very large plot of land, acquired by the Brush Company, conveniently situated as to supply of fuel and water, and quite free from the objection to the site of former electric works, in so far as there are no risks of causing inconvenience or annoyance from vibration or other trouble to residents. The company have erected a building covering 3,200 square feet, and divided into two by a partition wall forming the boiler and engine rooms. The boilers are made by the Babcock-Wilcox Company, and are of 150 H.P. each. The motive power is furnished by two inverted cylinder compound engines, designed by Raworth, the engineer to the Brush Electrical Engineering Company, of 75 H.P. each. The dynamos are Mordey alternators, each capable of supplying the primary circuit of converters, lighting in all 2,000 lamps. The exciter is a Victoria machine, driven by friction gear, by a smaller engine of the same type as those driving the high tension dynamos. The speciality of the station is the splendid appliances for switching, and the care which has been devoted to minor details, such as fixing a jockey pulley to tighten the endless rope driving.

There seems to be a general desire for uniformity expressed in central station work, as low tension machines are now nearly always driven direct by Willans engines, or high-speed direct-acting engines of a like type, so that a medium speed dynamo may be coupled to the engine shaft.

It is usual in present practice to keep the pressure constant, not at the station, but at some point about the centre of the supply network; and in this connection a volt indicator is quite as useful

in regular work as a voltmeter. It is scarcely necessary to explain that by the term indicator is meant an apparatus which will show whether the volts are or are not at their normal value, and, if not, in which direction they are at fault. Such an instrument has only to be calibrated for one particular value, and ought for that reason alone to be much cheaper than a meter. Moreover, as it is only intended to be used at one current strength, there is no objection to the employment of soft iron.

Probably some use might be found for an alternating current volt indicator. The principle of alternating current deflection to which Prof. Fleming in this country, and Prof. Elihu Thomson in America, have devoted attention, would obviously lend itself to this end. The writer is not aware of any application having yet been made of this principle to any instrument for electric lighting work.

The problem of electric lighting from central stations is comparatively easy, if plant can be put down near the centre of the area to be supplied, with the right of way, and powers granted by a provisional order.

When permission can be obtained to lay cables underground, a three-wire system at 220 volts, or continuous current transformer system at 500 volts, has much to recommend it in comparison with the alternating current. Much has been said on the subject of the cost of copper; and the habit of basing estimates of the cost of a network on the price of copper is one to be avoided, having led to erroneous conclusions much too favourable to systems using high E.M.F.

There can be no doubt that there is a possibility of the high tension circuit making contact with the low tension circuit winding in an alternating transformer, and since the former is always joined to the supply leads of the network, there is a constant loss due to want of balance between the primary E.M.F., and the back induction of that coil. With low tension working the highest efficiency occurs during the minimum load, that is for the greater part of the twenty-four hours; while with the high tension, alternating current, the highest efficiency is at full load, and for the greater part of the day the loss is very high—higher than the loss in the low tension system when working at maximum load.

To sum up; on examining all sides of the question, the rival merits of the various systems seem very evenly balanced; each method of distribution is showing itself, *under given circumstances*, to be a sound and practical system to adopt; each method has its own special advantages and disadvantages, and time alone can show which of the many proposed is fittest to survive upon the largest scale; or whether they are all doomed to fall before a system combining the merits and avoiding the demerits of all others.

## LONDON COUNTY COUNCIL.

At the weekly meeting, held at Spring Gardens, the Chairman of the Highways Committee submitted the following report:—

The Electric Lighting Acts impose on the council the duty of testing meters for electric energy supplied for any purposes. In order to perform this duty properly, we are advised that the meters should be tested by means of a current the same in quality, character and periodicity as that for which the meters are to be used. It is therefore desirable that the council should obtain power to require any electric lighting company to supply energy to the testing station now being established, and to any others which may be hereafter established, where such testing station is beyond the limits of the company's area of supply, such energy to be used only for the purposes of testing. They, therefore, recommend that the Parliamentary Committee be instructed to insert in the Council's General Powers Bill of next session a clause giving the council power to require any electric lighting company to supply electrical energy to the council's electric testing stations, even if the station for which the supply is required be beyond the limits of the company's area of supply, and authorising such company, subject to the usual notices, to break up streets for the purpose of laying the mains necessary to afford such supply to the testing station.

The Electric Supply Corporation has served two notices, one (registered No. 128), dated October 30th, 1890 (1 plan), of intention to lay mains in West Strand (part of), Charing Cross (part of), Northumberland Avenue (part of), and the other (registered No. 129), dated November 3rd, 1890 (1 plan), of intention to lay mains in the Strand (part of), and Bedford Street (part of). The proposed interference with so busy a thoroughfare as the Strand is to be deprecated; but the company had statutory power to lay its mains there, and although it has endeavoured by negotiation to adopt a route for these mains in the area of supply of an adjoining company, so as to avoid to some extent the interference with the Strand, it has been unsuccessful. In these circumstances, they were of opinion that the council would not be justified in withholding its consent to the works referred to in the notices, and recommend that the sanction of the council be given to the works referred to in the two notices (registered Nos. 128 and 129), of the Electricity Supply Corporation, dated October 30th and November 3rd, 1890, respectively, upon condition that two days' notice be given to the council's engineer before any of the works are commenced; that the concrete floor of the road-boxes be made 9 inches thick; that the York stone at the top be 4 inches thick; that the longitudinal girders in all the boxes be

laid on 3-inch stone templates the full thickness of the brickwork; that the work when commenced shall be continued by day and night shifts, and be carried on so that the traffic shall not be interfered with more than is absolutely necessary; and that the work shall be completed within the shortest time possible.

They had considered a notice (registered No. 130), of the Westminster Electric Supply Corporation, of intention to lay mains in Chesterfield Gardens (1 plan). There appears to be no objection to the proposed works, and recommend that the sanction of the council be given to the works referred to in the notice (registered No. 130), of the Westminster Electric Supply Corporation, dated 6th November, 1890, upon condition that the company do give two days' notice to the council's engineer before commencing the work; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the boxes to be used shall consist of iron frames filled in with materials to suit the paving.

A notice (Registered No. 131), dated 6th November, 1890, has been received from the Metropolitan Electric Supply Company, of intention to lay mains in Exeter Street, Strand (1 plan). The proposed works are of the same character as those of this company previously sanctioned by the council, and recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 131) dated 6th November, 1890, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the council's engineer before commencing the works; that the mains be inclosed in 5-inch iron pipe, and be laid under the footways wherever it is found practicable to do so; that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving; and that the works generally shall be of the description approved by the council on 1st October, 1889.

They had considered a notice, dated November 11th, 1890 (Registered No. 132), from the Kensington and Knightsbridge Electric Lighting Company, of a proposed extension in Church Street (1 plan), and a further notice (Registered No. 133) from the same company, dated November 12th, 1890, of a proposed extension in Hyde Park Gate. The works referred to in these notices are of the ordinary character and it was recommended that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 132 and 133) of the Kensington and Knightsbridge Electric Lighting Company, dated November 11th and November 12th, 1890, respectively.

They had considered an application from the National Telephone Company for permission to lay two lead-covered cables along the entire length of the council's subways between the Mansion House and Westminster Bridge. We are advised that these are subways to which the Metropolitan Subways Act, 1868, applies, and that the council has no power to charge rent for the use of them, but can only make a charge for supervision. There appears to be no objection to these cables being laid in the subway; and therefore recommend that the National Telephone Company be allowed to lay two lead-covered cables in the subways between the Mansion House and Westminster Bridge, upon condition that the cables referred to be laid in such position as the council's engineer may direct, and that the work of laying them be carried out to his satisfaction; that all damage which may be done to the subway in the execution of the work be made good by, and at the expense of the company; and further that the company do undertake to pay such charges, in respect of supervision of all its cables now or hereafter to be placed in the subways, as may be agreed upon between the council and the company at a future time.

## THE ELECTRICAL BEHAVIOUR OF CERTAIN AMALGAMS.

A RECENT issue of the *Zeitschrift für Physikalisches Chemie* contains an interesting account of an investigation into the magnitude of the polarisation given by various amalgams in a solution of the corresponding chloride against zinc amalgam. The author is Mons. Le Blanc.

The apparatus employed in this investigation was of an extremely ingenious character; a prominent feature in it was a large tuning fork, which was so adjusted that its vibrations allowed the electromotive force of polarisation to be measured while the primary current was, practically, flowing constantly.

A means of estimating the relative stability of the various amalgams was afforded by the rate of fall of the degree of polarisation after the primary current was interrupted.

Le Blanc found that amongst the amalgams of the metals of the alkalis and alkaline earths, those of lithium and magnesium are the least stable.

A current of electricity from a battery of eight Leclanché cells was passed for about ten minutes in the case of a number of amalgams; with nearly all of

them there was but a very slight disengagement of gas. With the amalgams of magnesium and lithium, however, there was a comparatively active evolution of gas.

It was found by Le Blanc that when a mixture of solutions of zinc chloride and hydrochloric acid were dealt with, a quantity of zinc amalgam was deposited at the negative pole; this, he considers, indicates that atomic hydrogen displaces the metal zinc in its salts.

A new light is thrown upon the vexed question of ammonium and alkyl ammonium amalgams. Most of the text-books question the existence of ammonium amalgam. Let us take an instance and quote from a very well-known book. "When a solution of ammonium chloride is poured over sodium amalgam a soft slimy mass is formed, which swells up to many times the original bulk of the sodium amalgam. This curious substance has been termed an ammonium-amalgam, on the assumption that it was a combination of the radicle  $NH_4$  with mercury. In reality, however, it is nothing but a mercurial froth inflated with a mixture of ammonia and hydrogen."

Ammonium-amalgam was discovered "almost simultaneously by Berzelius and Pontin (vide Gilbert's *Annalen der Physik und Chemie*, vol. vi., p. 260) and by Seebeck (vide *Gehlen, Allg. Journ. Chemie*, vol. v., p. 482). It can be readily obtained when a current from a galvanic battery is passed through aqueous ammonia or through an aqueous solution of an ammonium salt containing metallic mercury placed in connection with the negative pole. The same substance is formed when a globule of mercury is placed on a piece of moistened sal-ammoniac and connected with the negative side of a voltaic battery of very moderate power, the circuit being completed through a platinum plate upon which the sal-ammoniac rests; decomposition of the latter rapidly ensues, and ammonium amalgam is formed. Sir Humphrey Davy described it as a butter-like mass of a grey metallic appearance, and much lighter than water. At ordinary temperatures it quickly decomposes into mercury, ammonia and free hydrogen, but at the freezing point it crystallises in cubes, and according to Grove does not decompose spontaneously.

Endless discussions have taken place over this amalgam, and the balance of opinion has been fairly evenly divided. Le Blanc's work sets this question at rest, for the phenomena which he observed with solutions of the ammonium chlorides are quite comparable with those obtained when the metallic chlorides are employed. This goes to prove that the ammonium and alkyl-ammonium amalgams have an actual existence.

These amalgams, however, as might be supposed, are much less stable than the metallic amalgams usually are—a point which is well illustrated by the fact that the electromotive force of polarisation falls off in a relatively rapid degree as the primary current ceases to flow.

Besides the interesting amalgam of the hypothetical radicle ammonium. Le Blanc investigated the following compound radicle amalgams:—

Methyl-ammonium amalgam.  
Ethyl-ammonium amalgam.  
Di-methyl-ammonium amalgam.  
Di-ethyl-ammonium amalgam.  
Tri-methyl-ammonium amalgam.  
Tri-ethyl-ammonium amalgam.  
Tetra-methyl-ammonium amalgam.

Of these the most unstable is tri-ethyl-ammonium amalgam, and it is rather doubtful whether it really exists. The tri-methyl and the di-ethyl-ammonium amalgams are also extremely unstable.

The formation of a mercury "froth" on the surface of the liquid during the process of electrolysis has hitherto been held to be a capital indication of the formation of an amalgam, but this view must be modified. Le Blanc's investigation shows that in the case of the ethyl-ammonium amalgam no froth rises to the surface, and yet the electrical behaviour shows beyond a shadow

of doubt that a definite and comparatively stable amalgam has been formed.

Those of our readers who know German, and may wish to examine into the details of this interesting piece of research may consult the "*Zeitschrift für Physikalische Chemie*," vol. v., commencing at page 467.

## FIRE AT GROSVENOR GALLERY CENTRAL STATION.

MR. FERRANTI has kindly supplied us with the following facts relating to the fire at the Grosvenor Gallery:—

"Up till recently the Grosvenor Station was supplying the whole of the lights of the London Electric Supply Corporation. Due to the obtaining of an injunction by the neighbours, the corporation has been obliged to abandon this station for generating purposes, and use it only for a distributing station. It was necessary, so far as was possible, to stop down the Grosvenor generating station, turn out a certain portion of the machinery which had been running there, and instal the necessary converting machinery for the purpose of transforming from the high tension to the intermediate tension for supplying to the customers. All this had to be done with the minimum of delay. It was, therefore, a case of stopping down on Saturday nights, and working as hard as possible to finish the installation of the transformer machinery by as early an hour on Sunday afternoons as possible. This process was partly done. The whole of the work which was put in was of an entirely temporary nature, India-rubber-covered wires being used for carrying the current, light woodwork being used to support these wires, and the switches instead of being upon permanent supports were held by woodwork."

"The accident occurred at 6:30 on Saturday morning, owing to the action of a linesman in plugging on a fresh set of converters. The man was not sufficiently cool for this particular purpose. Hesitating in putting on the switch, it arced slightly: instead of pushing it in, he drew it back and broke the contact. The heated surfaces, together with the 5,000 volts pressure which was being used, caused the arc to maintain. It ran up the woodwork and set light to the ceiling, which was composed of cross-boards with tar between for the purpose of keeping out moisture from the tank which formed the roof. The whole place was burned down in the brief space of twenty minutes. An hour after the accident occurred the whole place was quiet and fairly cool. The linesman had ample opportunity of entirely stopping any damage from his first carelessness, because the switch which he put on was only a plug, and meant for connecting a circuit, there being a large switch within a yard's distance for breaking the supply passing through the plug switches. If he had been too frightened to turn off the switch, he had again another safeguard in the safety switch at the end of the room, which would cut off the whole supply from Deptford. He also had the option of signalling to Deptford to stop the supply, but this was stopped before the man could have finished signalling, as they saw by the action of the ammeters and voltmeters at Deptford that something was wrong in London."

We believe that the cost of the destroyed apparatus amounts to between £15,000 and £20,000, all of which was uninsured.

**Electric Lighting in Panama.**—An electric light company, acting under contract with the Municipal Government, has introduced the electric light for public and private purposes in the town of Panama. The lighting of the streets is effected by 43 arc lamps, and 300 glow lamps are installed on private premises,

## NOTES.

**The Electric Light at Bath.**—At a meeting of the Town Council last week, Mr. Sturges, on moving the adoption of the report of the Special Electric Lighting Committee, complimented Mr. Massingham upon the success of his installation. He also congratulated Bath upon having taken the position it had done in the matter of the electric light, and upon this important and beautiful improvement in the lighting of the town and houses having been so readily adopted. He advocated an independent inspection by a leading electrician. Mr. Massingham had stated that he would be better satisfied if they employed an expert of the highest standing they could find—that was Mr. Preece; and he would move, as an addition to the report, that they employ a scientist of sufficient eminence to inspect the whole of the works and report to the council. Mr. Sturges added that the Board of Trade would insist on inserting a clause in Mr. Massingham's license that he should not be compelled to sell at the end of seven years, if he wanted an extension. Mr. Massingham, however, was perfectly willing not to have such a clause, but the Board of Trade insisted that he should. In the course of the discussion which ensued, General Burn expressed an opinion that the new illuminant was an immense improvement on the old gas light, and as a practical proof of its superiority he mentioned that a threepenny piece placed on the pavement between two of the electric standards could be seen easily, whereas it was impossible to detect a similar coin placed on the pavement between two gas lamps. At the close of the discussion the report was unanimously adopted.

**Electric Lighting at Stroud.**—A public meeting a few nights ago at Stroud approved of a scheme for lighting the town by electricity.

**Ship Lighting.**—Last week Messrs. David W. Henderson, Glasgow, launched to the order of Messrs. J. and A. Allan, the steel screw steamer *Mongolian*. She is fitted throughout with the electric light. A sister ship to the *Mongolian* will be launched in the spring of next year.

**French Submarine Cables.**—In reviewing the work now being accomplished in the West Indies by the Société Française des Télégraphes Sous-marins, and while congratulating the Ministry for the Colonies on the zeal it has displayed in this direction, the Paris technical press points out that there are other and more urgent telegraphic communications to be established. The places with the most pressing need for cable connection are Réunion, Maurice, and Madagascar, which represent most important interests, long suffering from inattention; the Comoro Islands and New Caledonia, also, claim the consideration of Government.

**Important to Electric Light Companies.**—At a recent meeting of the Paris Municipal Council the following measures were agreed to:—Parliament is invited to pass a special law to assimilate the electric lighting industry with those enterprises which, being considered dangerous, are under the constant supervision of the Prefecture of Police. The administration is invited to inscribe in the conditions of contract for electrical companies, whenever a new concession may be asked for, the express obligation to employ smoke-consuming apparatus, or to make use of combustibles which do not give off smoke.

**Canal Traffic.**—A German contemporary states that a Magdeburg firm will shortly make experiments on the Finow Canal with boats and timber rafts worked by electricity.

**A Bordeaux Exhibition.**—An electrical section is being formed in this international exhibition, which is to be opened in Bordeaux in May next.

**A Long Price.**—The English and German electric light companies in Madrid maintain the high price of 14d. to 15d. per unit. The expression "go to Bath," to inspect Mr. Massingham's lighting and charges, must now be changed to "go to Madrid."

**Italian Electro-Technical Schools.**—There are three electro-technical schools in Italy. One is situated in Milan, the second in Turin, and the third in Naples.

**Another Franco-Danish Cable.**—The President of the Republic has just signed a decree regulating the laying and working of a second telegraphic cable between Calais and Denmark.

**The Theatrephone.**—The theatrephone is about to be installed in several of the Paris clubs, notably in that of the Union Artistique, where it will shortly be at work.

**Personal.**—Sir Frederick Abel, F.R.S., has accepted the seat on the board of J. C. and J. Field, rendered vacant by the death of Mr. G. Maule.

**The Royal Society.**—The following papers were down for reading yesterday:—Prof. J. V. Jones, "On the Determination of the Specific Resistance of Mercury in Absolute Measure." Dr. Hopkinson, F.R.S., "Magnetism and Recalescence."

**The Old Students' Association.**—A Cinderella dance will be held at the Westminster Town Hall on Friday, December 12th, 1890. Tickets, 3s. 6d. each, may be obtained from the members of the committee, or from Mr. Reginald J. Jones, hon. sec.

**A Valuable Publication.**—The sixth edition of "Electric Lighting and the Management of Accumulators," by Sir David Salomons, Bart., will shortly be published.

**Tenders Wanted.**—Bombay.—Sealed tenders will be received by the Municipal Commissioner for the city of Bombay up to 1 p.m. on February 16th for experimental lighting by electricity of certain streets of the city of Bombay for two years. Forms of tender and schedule of conditions, and a sketch of the portion of the city, showing the streets to be lighted, may, on payment of £1 sterling, be obtained from Messrs. E. W. and R. Oliver, 1, Corbet Court, Gracechurch Street, London, E.C., who will, on application, give any further information that may be required. Tenders must be accompanied by a deposit of one thousand rupees in cash (not to bear interest), or in public securities for that amount to be paid to the chief accountant of the Municipality of Bombay, which will be forfeited to the corporation in case of refusal to sign the contract embodying the conditions mentioned in the schedule above referred to. A further payment, to make the total deposit equivalent to 5 per cent. on the contract amount, will have to be made by the contractor whose tender may be accepted, before signing the contract. Mr. Rienzi Walton, executive engineer, Municipality, Bombay.

**Edmonton.**—For lighting public hall, stores, &c., Letters to Mr. Walker, people's provider, Upper Edmonton.

**Mr. Tesla on Sound Views.**—In a letter to *Industries* on alternating motors, Mr. Nikola Tesla concludes an able letter as follows:—"You state that I have misinterpreted my results, and it looks as though you believe my views to be unsound. Your arguments are those of an eminent scholar. I was myself a fair scholar. For years I pondered, so to speak, day and night over books, and filled my head with sound views—very sound ones, indeed—those of others. But I could not get to practical results. I then began to work and think independently. Gradually my views became unsound, but they conducted me to some sound results."

**Failure of Accumulator Traction in Australia.**—The Victorian *Electrical and Telegraphic Journal* for last month contains the following suggestive paragraphs:—

"The Sandhurst and Eaglehawk Electric Tramway Company ceased running on Wednesday, 24th September, the accumulator system of traction having proved a failure. This will be noted with regret by the public as well as shareholders. The latter are worthy of much praise for the persistent resolve to succeed if success were attainable."

"It is curious to note that the only accumulator-driven system which was alleged to be a commercial success, that on the Barking Road, London, is now proved to be a commercial failure, to judge by the reports in the electrical press of late date."

"This company were using the same cars and motors as the Sandhurst Company. This latter company may, if the requisite power be obtained, adopt the overhead wire system, which has proved successful in America."

**Western Counties and South Wales Telephone Company.**—We must take this opportunity of expressing satisfaction at the continuous progress of this company, which forms at once an example for other enterprises with far greater pretensions. A few months ago the company was approached by the Port of Plymouth Chamber of Commerce with a view to establishing a signal station on Rame Head for reporting by telephone to Plymouth all vessels passing up or down Channel or entering the port, as well as casualties and other shipping news of interest. No time has been lost, and provided that arrangements can be made with the Admiralty, the station will be in working order in a few weeks. The Devon and Cornwall Homœopathic Dispensary and Cottage Hospital is in connection with the exchange system free of charge, and among the more recent developments of the system is the conversion of the single trunk line to Plympton, Ivybridge, and Avonwick into a metallic circuit or double wire. A tradesman at Plympton can now converse with any subscriber in the Three Towns for an annual rental of £10, and a private resident will have the same privilege for £5 per annum, provided he lives within a quarter of a mile from the Plympton office, £1 5s. per annum being charged for every additional quarter of a mile. Similar services to this will be established at other places early in the new year.

**Electric Light Mains.**—Messrs. Henley's Telegraph Works Company, Limited, has favoured us with samples of electric light mains covered with vulcanized India-rubber which the company has been, and is, supplying to the Kensington and Knightsbridge Electric Supply Company, Westminster Electric Supply Company, Notting Hill Company, Crompton & Co., &c. It is believed that the largest of these samples, viz., 61/10s is the heaviest vulcanized India-rubber cable that has ever been made. The weight of the conductor alone is  $7\frac{1}{4}$  tons, and its sectional area is  $\frac{3}{4}$  square inch. Judging from the samples before us, the company should feel itself well satisfied with its manufactures both electrically and mechanically.

**"Darkest England and the Way Out."**—The staff and men of the dynamo department in the works of W. T. Goolden & Co. having resolved to raise a subscription to aid General Booth in his great work of endeavouring to raise the lapsed masses of his fellow men, it was at once started vigorously, and chiefly through the sympathetic influence of C. W. Atkinson, Esq., the sum of six guineas was in a few hours collected and forwarded to General Booth last Saturday. The instrument department staff may possibly send in a contribution, but no definite steps have up till now been taken in the matter.

**A New Cable.**—The Great Northern Telegraph Company is about to lay a new direct cable between Fano, off the West Coast of Jutland, and Calais.

**Electrical Engineers Students' Meetings.**—There will be no students' meeting held on Friday next, as advertised. On the 5th proximo, Mr. Garret will read a paper on "Search Light Work."

**Catalogue.**—We have received a catalogue of technical books "On the Mechanical Arts" from the Britannia Company, Colchester.

**Telephones in Russia.**—A French company has recently obtained a concession from the Russian Government for the construction of a telephone system between St. Petersburg, Moscow, Warsaw, and Berlin. The charge for the use of the telephone will be 8 francs for the first minute, and 4 francs each additional minute.

**Prices of Incandescent Lamps.**—Mr. C. J. Robertson, writing from Aldersgate Street, says:—"I notice in your last issue a note on the present low price of incandescent lamps in the States (*i.e.*, 44 cents. each). I thought it might interest you to hear that I am myself supplying lamps (made within 300 miles of London), of a quality and durability second to none—including the 'Edison-Swan'—at the still lower price of 1s. 7d. (*i.e.*, 38 cents, American) each, fitted and delivered free, and there is every prospect of lowering this price in the near future."

**Tapping Holes in Porcelain with Fine Threads.**—Messrs. Buller's, Limited, send us the following note:—"From the paragraph in the REVIEW of last week, it might be inferred that there had been some difficulty in obtaining porcelain fittings for electric lighting with holes tapped to receive metal screws. For many years past we have tapped holes in porcelain to fit metal screws with complete success, and therefore when the demand for this feature in electric lighting ware came, we had no difficulty in meeting it. We beg to send you a ceiling rose with screwed holes, made by us some months ago. To our customers we have supplied many thousand pieces of ware with tapped holes, and the results have already been very satisfactory. Our screws are made to a series of standard gauges, which in diameter and pitch cover the whole requirements of the trade." Certainly the sample sent to us is an excellent specimen of manufacture, the screws running perfectly true and smooth.

**The Government and the Telephone.**—Under this heading an article appeared recently in the *Scotsman* in which attention is drawn to the Van Rysselberghe system of telephoning on ordinary working telegraph wires. It is stated that, "Hitherto not a step has been taken towards the adoption of the system in this country;" and again, "If it should be found as available here as it is in Belgium and in France—and there is no reason why it should not—the Government will have the most comprehensive means of telephoning to be found in the country," and much more to the same effect. The writer of the article was evidently ignorant of what he was writing about, otherwise he would not have argued in the strain he did. The Van Rysselberghe system has, we believe, been tried in this country and found to be a failure, first, because it necessitates the addition of electro-magnets in the line wire, which cuts down the working speed of the fast speed apparatus so widely used, and secondly, because the addition of these electro-magnets renders it necessary to greatly increase the ordinary working battery power of the telegraph circuits. In the case of Belgium, we believe, it has been found necessary to double the power on the circuits all round, and the consequent expense and trouble more than counterbalances the gain of telephone working being possible. It is whispered, also, that the Telegraph Service is by no means pleased with the system, but that it has, unfortunately, bound its hands in such a way, that they cannot be freed.

**Greenock Philosophical Society.**—Mr. A. Denny, Dumbarton, last Friday night, lectured to this society on "Electricity, and its Practical Applications." The hall was electrically lighted for the occasion, and the lecture was interspersed with numerous experiments and illustrations.

**The Institution of Electrical Engineers.**—The next meeting will be held on Thursday, 27th November, at 8.0 p.m., when the adjourned discussion on the following papers will be continued:—"The Efficiency of Secondary Cells;" "On the Chemistry of Secondary Cells;" by Prof. W. E. Ayrton, F.R.S., Vice-President; C. G. Lamb, B.Sc., and E. W. Smith, associates.

**The National Telephone Company's Exchanges.**—The National Telephone Company, Limited, announce that the trunk line between the London, Manchester, Liverpool, and Birmingham Exchanges is now open to the public.

**The Electro-Deposition of Copper.**—We have received since our Correspondence pages went to press a long letter from Mr. W. Stepany Rawson, who simply reiterates the contents of his previous communication without in any way making his case better. Out of politeness to him, and also to show how much more diplomatic it is to beat about the bush than to come to an issue, we shall publish his letter in our next, together with a report on the Elmore process formulated by M. Secretan and others, which is so deliciously vague that our readers may anticipate a real literary treat. We have failed to elicit the information from Mr. Rawson which we requested, for he steers clear of the rock on which he would have split by declaring that the Elmore Company has objected to the figures of cost being given by him. While on this topic, it may not be amiss to call attention to a letter from Mr. William Elmore, which appeared yesterday in the *Financial Times*. This gentleman's object is to allay the alarm which has been caused by the depreciation of Elmore shares, but we doubt very much whether his explanations will have the desired effect. So far as the company's works are concerned, says he, they continue daily to improve; but what the general public desire to see is not so much a daily improvement in works which are supposed to turn out some scores of tons of copper per week, and which certainly ought to have been in readiness months ago, as a real sale for the manufactured articles. We have every reason to believe that up to the present date five tons would cover all that the Elmore Company has turned out, and Mr. Elmore's statement that he has increased his holding of shares during the past week may show either confidence in his system, or, on the other hand, that he is trying to keep the market firm for yet a little while to float still another company. How near to the truth this last supposition may be we leave for commercially inclined readers to determine, merely calling attention to the following extract from an article "Still more Elmore," in the *Financial Times* of Wednesday, and which is well worthy of perusal in full:—"There are now four Elmore Companies, all producing no end of circulars and no end of securities, but no patent copper. Now there is to be a fifth. It is not to produce copper. Oh, dear no! It is to be called a Trust, and its function is to foist a lot of Elmore vendor shares, which of course are unsaleable just now, on the public. This is the prettiest thing in 'trust' schemes that has been evolved, and it is also the culminating point of the ingenuity of the Elmore promoters. The chief advantage of the scheme, as set out in the latest Elmore circular, is that the public will be enabled, by means of this trust, to invest in the valuable Elmore securities." To judge from the fall in the price of shares of the original company the public requires a good deal of persuasion to indulge in the luxury of Elmore securities at fancy values, and it is not likely to jump at the chance of obtaining diluted interest in the worst of them.

**The Northfleet Electric Tram Line.**—The series electrical traction system at Northfleet has been discontinued. The line, as is well known, was for demonstrative purposes only, and its object having now been attained, there is no further reason for incurring the large expense necessitated by the smallness of the local traffic, and the heavy rental and charges imposed by the Gravesend, Rosherville and Northfleet Tramway Company, through whom the Parliamentary powers were obtained. Careful accounts have been kept of the cost of running for the last six months, and from these, when audited, the actual cost of motive power on the series system will be made public.

**To Elmore Shareholders.**—On the 12th September, 1876, Mr. Henry Wilde, of Manchester, patented an invention (Specification No. 3,569) for "Improvements in the manufacture of metal rollers for printing calico and for other purposes." It may be interesting to the holders of Elmore shares to compare this with what they know of the process on which they have built their hopes, and for this purpose we give the following extract from the text:—"Now my present improvements consists, firstly, in a method of securing a sufficient amount of adhesion between the iron and deposited copper surfaces, to enable the roller to withstand the various engraving and other operations without the separation of the metals. For this purpose the iron roller, before receiving a coating of copper from a hot cyanide solution of copper, is heated to a temperature ranging from 150° to 212° Fahrenheit, by plunging it into boiling water, or by other means. The said roller, after receiving a film deposit of copper from the cyanide solution, is then transferred to the bath containing a sulphate solution of copper, where it receives one or more thin coatings of copper. *These coatings are subjected to considerable pressure by the action of a burnishing roller of hardened steel, for the double purpose of forcing the deposited copper into closer contact with the iron, and detecting any want of adhesion between the two metals.* The burnished coppered roller is then replaced in the bath of sulphate of copper solution, and *subjected to the action of the electric current until the desired thickness of copper deposit is obtained.* Before each of the depositing operations the surface of the roller is thoroughly cleansed by scouring and washing in clean water, as is well understood. Having thus stated the nature of my invention, and described the manner of performing the same, I declare that I claim,—First. Heating iron rollers to prepare them for receiving a film deposit of copper from a cyanide solution. Secondly. *Depositing one or more thin coatings of copper from a sulphate solution, and burnishing the same before the final coating is deposited for the purpose described.*

**Electrical Engineers Conversazione.**—The annual *conversazione* of this Institution was held on Wednesday, the 19th, in the Galleries of the Society of Painters in Water Colours, and was the largest and most brilliant of a long series. The company, numbering about 1,000, was received by the president, Dr. John Hopkinson, and Mrs. Hopkinson. A large number of distinguished visitors and scientific men were present, including the Solicitor-General, Sir Frederick Bramwell, Dr. Gladstone, Prof. Frankland, Sir Albert Cappel, Sir James Douglass, Sir Douglas Galton, Sir David Salomons, Sir Henry Mance, Major-General C. E. Webber, &c. The Coldstream Guards' band played in the Galleries and the Bijou Orchestra in the Prince's Hall. Ladies formed a very considerable portion of the concourse, and added brilliancy to the scene.

**The Mistake Obvious.**—In reference to our note last week, "A 200,000-watt Arc Lamp," Mons. W. de Fonvielle writes to explain that by a misprint in a French contemporary, 50 volts became 500. The mistake, we need scarcely say, was doubtless apparent to our readers, and, as our correspondent remarks, is scarcely worth referring to again.

**Electric Light at Madame Tussaud's.**—A complete installation of the electric light at Madame Tussaud's has been erected by Messrs. Drake and Gorham, superintended by Mr. Gisbert Kapp. Two dynamos are used, driven by two of Crossley's gas engines of 25 horsepower, in addition to which batteries are employed. We may mention that the whole of the work (excavating, building engine-house, &c.) had to be undertaken by the electricians, and the result is a very neat and compact station.

**Edison Underground Work.**—The Edison Company of Boston has two stations supplying 32,000 incandescence lamps and 50 Ward arc lights, with a motive power of 1,400 H.P. The underground system has an extension of two miles, with 40 miles of feeders and mains. The longest feeder is about 6,000 feet. Railway bridges are crossed by means of a Clark specially prepared cable, pulled through a 3-inch gas pipe. The crossing to South Boston will be made by an armoured Clark submarine cable.

**Electricity in a Silver Mine.**—Since the introduction of electric machinery of the Westinghouse manufacture into several Pennsylvania coal mines, the demand for that company's apparatus is rapidly increasing. The Westinghouse Company is now engaged in manufacturing power apparatus for the operation of a silver mine owned by the Gold King Mining Company of Telluride, Colo., L. A. Munn of that city being the president of the company. The mine in question is situated on the top of a mountain about 2,000 feet high, and as the cost of coal is a great factor in the operation of a mine under such circumstances, the advantages of electric power over steam can be easily appreciated.

**The Priority of the Electrical Gyroscope.**—M. Dumoulin-Froment claims against M. Trouvé the invention of the electrical gyroscope. It appears that the gyroscope was invented by Foucault in 1850, and in 1867 M. Froment showed in the Champs de Mars Palace an instrument worked by electrical mechanism, whilst M. Trouvé only presented his to the Académie des Sciences in September last. Our readers may recollect that we gave an illustrated description of an electrical gyroscope devised by Mr. G. M. Hopkins in our issue for August 15th, 1878.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Brush Electrical Engineering Company, Limited.**—The annual return of this company, made up to the 22nd September, was filed on the 12th inst. The nominal capital is £750,000 divided into 150,000 ordinary shares of £3 each and 150,000 preference shares of £2 each. The shares taken are 76,978 ordinary and 68,996 preference shares, and upon 68,914 of the former and 68,914 of the latter the sum of £344,570 is considered as paid up. The full amount has been called upon the remaining shares, the total of the calls paid amounting to £24,353 10s. and unpaid £2 10s.

## NEW COMPANIES REGISTERED.

**Electricity and Electrical Engineering Newspaper Company, Limited.**—Capital £500, in £10 shares. Objects: To establish and work a newspaper devoted to the interests of electrical science in all its branches. Signatories (with 1 share each): Wm. Swan Sonnen-

schein, 62, Russell Square; H. Wigham, Uplands, East Sheen; R. Oswald Smith, 73, Eaton Square; F. C. Tilney, 126, Corbyn Street, Stroud Green; Julius Maier, Ph.D., 23, Melrose Gardens, S.W.; F. D. Summers, 13, Oberstein Road, Wandsworth; George Newnes, M.P., Wildcroft, Putney Heath. Registered, without special articles of association, by Bowman and Co., 21, Bedford Row. Registered office, 6, White Hart Street, Paternoster Square.

**Chagford and Devon Electric Light Company, Limited.**—Capital £2,000 in £1 shares. Objects: To carry out an agreement of 12th inst. for supplying electric light to Chagford, Devon. Signatories: J. Collins, F. Aggett, J. Underhill, L. Holmes, J. Smith, 1 share each; G. H. Reed (engineer), 5 shares, all of Chagford, Devon; E. Eaton, C.E., M.S.A., 27, Martin's Lane, London, E.C., 1 share. Registered 18th inst., without special articles of association, by J. Fleming, 27, Martin's Lane, E.C.

**Anglo-Mexican Saw Mills Company, Limited.**—Capital £5,000, in £1 shares. Objects: To carry on in Mexico the business of saw mill proprietors, and to acquire all necessary rights of using steam, electricity, or water power in connection therewith, and particularly to manufacture cigar boxes; to acquire and deal with patent machinery, apparatus and materials for the production and distribution of electricity. Signatories (with 1 share each), H. S. Sugden, Stroud Green, N.; F. H. Depree, 21, George Street, Portman Square; T. Seabrook, 126, Stanstead Road, Forest Hill; W. Hart, 27, Sandover Road, Camberwell; G. H. Lovell, Manor Road Leyton; A. Allwork, 229, Tufnell Park Road, N. The signatories are to appoint the first directors. Qualification, 10 shares. The company, in general meeting, will determine remuneration. Registered 14th. Solicitor, Mr. James Curtis, 1, Old Jewry Chambers.

**Ernest Scott and Mountain, Limited.**—Capital, £70,000 in £10 shares. Objects: To carry on business as electrical and general engineers. Signatories (with 1 share each): P. W. Bullock, 19, Portsea Place, Connaught Square; J. Aspinall, 34, Bourvan's Buildings, Edgware Road; J. McNab, Drapers' Gardens; W. Capel Slaughter, 21, Great Winchester Street; D. Scott, 12, York Street, Manchester; A. H. Bartlett, 21, Great Winchester Street; S. E. Preston, 21, Great Winchester Street. The signatories are to appoint the first directors; qualification, £1,000 in shares; remuneration, £200 per annum to each ordinary director. Registered 17th inst. by Slaughter and May, 21, Great Winchester Street.

**South Molton Shirt and Collar Manufacturing Company, Limited.**—Capital £5,000 in £10 shares. Objects: To manufacture shirts, collars and cuffs. To act as undertakers for the supply of electricity for lighting and other purposes. Signatories: W. J. Redler, Taunton, 35 shares; W. C. Rafarel, Barnstaple, 20 shares; D. J. C. Bush, South Molton, 10 shares; G. H. Crocker, South Molton, 10 shares; J. T. B. White, South Molton, 5 shares; D. B. Redler, Taunton, 5 shares; G. Bush, 34, Cleveland Square, Hyde Park, 10 shares. The signatories are to nominate the first directors; qualification £50 in shares. Registered 17th inst. by Riccard and Son, South Molton, North Devon.

**Electrolytic Syndicate, Limited.**—Capital £100,000, in £1 shares. Objects: To adopt the following agreements, particulars of which are not specified, viz.:—An agreement of 25th ult., between Wm. Elmore and Alfred Wells; an agreement of 24th ult., between Arthur Cooper and Alfred Wells; an agreement of 25th ult., between John Fraser and Alfred Wells; an agreement of 23rd ult., between Woodhouse and Rawson United, Limited, of the first part, Wm. Elmore, Frank Elmore, and Alexander Stanley Elmore, of the second part, and Alfred Wells, of the third part. To carry on business as miners, metallurgists, smelters, and electricians. Signatories (with 1 share each): J. Jepson Atkinson, Cosgrave Priory, North Hants; W. Elmore,

47, Clapham Road ; J. Thompson Cooper, Nightingale Lane, S.W. ; F. Safford, 2, Garden Court, Temple ; S. Evans, Lonsdale Chambers, Chancery Lane ; W. J. H. Tippet, 11, Maiden Lane ; W. J. Peck, Redcar. Registered 17th inst., without articles by the Metropolitan Provisional Syndicate, Limited, 27, Chancery Lane.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Swan United Electric Light Company, Limited.

THE eighth annual report of the directors, to be presented at the ordinary general meeting of the company next Tuesday, states that after paying all current charges, and making due allowance for depreciation, there is a credit balance of £44,477 15s. 10d. The directors recommend that out of this balance a dividend of 10 per cent. for the year be declared; an interim dividend at the rate of 6 per cent. per annum, amounting to £11,104 0s. 5d., has already been paid in respect to the first half of the year; the balance of the 10 per cent. for the entire year to be distributed in accordance with clause 77 of the articles of association, and to be payable on the 1st December next. This will absorb £24,921 17s. 7d., and leave £8,451 17s. 10d. to be carried forward.

The decision in the patent suit in Germany was given in favour of this company in the Court of Appeal in Berlin during the summer. The Allgemeine Electricitäts Gesellschaft have appealed from that decision to the Supreme Court at Leipzig. It is expected that the case will be heard and finally decided before Christmas.

The Compagnie Générale des Lampes Incandescentes in Paris have not yet been able to obtain a decision in the courts on the validity of their French patents, but they think that the case will be reached and a decision given during next spring. Their business is increasing, but the competition which they have to sustain compels them to sell lamps at a lower price than heretofore.

The directors who retire by rotation are F. R. Leyland, Esq., and W. C. Quilter, Esq., M.P., who, being eligible, will offer themselves for re-election.

Messrs. Welton, Jones & Co., the auditors, will also retire, and will offer themselves for re-election.

### The Allgemeine Electricitäts-Gesellschaft.

A REPORT and balance-sheet for the financial year 1889-90 has just been issued, which will be presented to the general meeting on the 29th inst. The document before us reveals a most satisfactory state of affairs of this company, which has been in existence for about eight years, and which may be regarded as the most prosperous concern of the kind in Europe.

The sales of electrical supplies reached the large figure of £550,000, as against £300,000 during the previous year, an increase in trade of over 45 per cent. The company employs a staff of 400 officials and 1,600 workmen. In view of this enormous development of business, it was decided to increase the capital from £800,000 to £1,000,000 (20 marks taken as equivalent to £1). The company has recently acquired the Sprague system of electric traction, which is now being put into operation on the Halle tramways. Among other industrial undertakings in which the Allgemeine Electricitäts-Gesellschaft is largely interested, may be mentioned the works of Messrs. Muller and Einbeck, where the accumulators of Tudor are being manufactured; a considerable share in the Edison General Electric Company of New York; the large brass foundry of Messrs. J. C. Spinn and Son, of Berlin; the Berlin Elektricitäts-Werke (central station); the Compagnie Internationale d'Electricité de Liège; the Aluminium Company at Neuhausen; the Key's Electric Company, Limited, of London; the Syndicate for Exploitation of the Waterpower of the River Rhine; the Compania General Madrilená de Electricidad, Madrid (central station, with 20,000 lamps).

Among the patents which this company has purchased from time to time are those of Maxim-Weston, Sprague and Edison, in addition to a large number of Continental ones. The cost of these has been written off year after year, and this item is now credited in the balance-sheet with one shilling; the sum written off last year amounting to £5,366.

The net trading profits of 1889-90 stand at £63,639, against £39,573 last year, but the net profits from all sources reached the respectable total of £113,101, which will be distributed as follows:

Returnable ... ..	£7,500
Extraordinary reserve ... ..	12,500
10 per cent. dividend on £800,000 ... ..	80,000
Board of directors ... ..	8,000
Sick fund and pensions ... ..	4,000
Carried forward, 1890-91 ... ..	1,101

£113,101

The company proposes to take part in the next Frankfurt Exhibition in a peculiar way; it intends to transmit to this city

300 H.P. of a waterfall 110 miles distant, the work to be carried out in conjunction with the Oerlikon Fabrik.

This is one of the most interesting reports to shareholders we have yet seen.

### Blackpool Electric Tramway Company, Limited.

IN the report to be presented at the sixth annual general meeting, to be held to-morrow (Saturday), the directors state that they have pleasure in submitting to the shareholders their sixth report and the accompanying statement of the accounts of the company for the year ending 31st October, 1890.

The revenue account shows a balance in hand for the year of £2,455 9s. 3d. Adding to this £231 5s. 10½d. from last year, makes an available amount of £2,686 15s. 1½d., of which the directors recommend the following disposal:—

	£	s.	d.
Dividend of 7½ per cent. on the called up share capital, free of tax ... ..	1,501	17	6
Depreciation and reserve fund ... ..	1,000	0	0
Balance to next year's account ... ..	184	17	7½
	£2,686	15	1½

The depreciation and reserve fund, with the addition of £1,000 as above recommended, will be £4,418 15s. 1d.

The number of passengers carried this year was 812,299. The number of miles run during the year was about 92,000.

The retiring directors are Messrs. Ormerod, Shaw and Smith, who are eligible for re-election.

Mr. Broadbent's services as managing director have been secured again for the coming year.

The transfer books of the company will be closed from the 13th to the 22nd November, inclusively.

### Eastern Extension Telegraph Company.

SIR JOHN PENDER presided on Wednesday afternoon at the offices, Winchester House, Old Broad Street, over an extraordinary general meeting of the shareholders of the Eastern Extension, Australasia, and China Telegraph Company, Limited.

The Chairman proposed the confirmation of the resolution passed at the meeting on the 22nd ult., and given in our issue of October 24th, for authorising the board from time to time to create and issue mortgage debenture stock of the company to an amount not exceeding one-third of the share capital for the time being issued and paid up, the stock to rank *pari passu* as a first charge on the undertaking and revenue of the company. The object of the meeting was, he said, to enable the directors to replace the £320,000 of 6 per cent. debentures by an issue of 4 per cent. debenture stock. This would effect a saving of £6,000 a year to the company.

The Marquis of Tweeddale seconded the motion.

Replying to questions, the Chairman said that they proposed to take 5 per cent. on application, 5 per cent. on allotment, and 90 per cent. on the 15th January. The 1st of February was the day on which they would be obliged to have the money ready to redeem the 6 per cent. bonds.

The motion was unanimously confirmed.

The Chairman afterwards observed that the present was rather an unfortunate time for the operation, but he thought they might congratulate themselves upon the fact that during all the existing exceptionally severe crisis their stocks had not varied ¼ per cent. Their proprietary, however, was one which was pretty free from Stock Exchange difficulties—persons having homes and dependent on small incomes, and who were able to appreciate steady and regular dividends.

A vote of thanks to the chairman closed the meeting.

**Paris Edison Company.**—The Edison Company of Paris, which has a share capital of 10 million francs, made a gross profit of 1,082,922 francs for the year 1889-90, and a net profit of 350,264 francs. A dividend of 22½ francs was declared on the original shares, and 4½ francs on the new shares.

**The Electric Construction Corporation, Limited.**—Subject to final audit, the directors of the above company have decided to declare a dividend of 6 per cent. per annum upon the ordinary share capital of the corporation for the past year.

**Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited.**—The transfer books will be closed from December 1st to December 8th inclusive, for the purpose of paying a dividend.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 14th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,087.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending November 14th were £5,249.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (November 19.)	Closing Quotation. (November 20.)	Business done during week ending November 20, 1890.
					Highest. Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	99 — 102	97 — 100	102 99
1,549,160	Anglo-American Telegraph, Limited	Stock	49 — 50	48 — 49	49½ 48½
2,725,420	Do. do. 6 p. c. Preferred	Stock	85 — 86	84 — 85	85½ 84½
2,725,420	Do. do. Deferred	Stock	13 — 13½	12½ — 13½	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 11½	10½ — 11½	11½ 11½
84,500	Do. do. 5 p. c. Bonds	100	101 — 103	101 — 103	101 — 103
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 — 108	104 — 108	104 — 108
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 1½	1½ — 1½	1½ — 1½
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2	1½ — 2
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104	103½
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	½ — ½	½ — ½	½ — ½
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½	5½ — 5½
16,000	Cuba Telegraph, Limited	10	11½ — 12	11½ — 12	12 11½
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	18 17
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4½	3½ — 4½	4½
6,000	Do. do. 10 p. c. Preference	5	8½ — 9½	8½ — 9½	9½
60,710	Direct United States Cable, Limited, 1877	20	10 — 10½	9½ — 10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 13½	13½ — 13½	13½
70,000	Do. do. 6 p. c. Preference	10	14½ — 15½	14½ — 15½	14½
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	106½
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	103 — 106	103 — 106	105½ 105
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13½ — 14½	13½ — 14	14½ 14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102	100 — 102
91,800	{ Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326 }	100	102 — 105	102 — 105	102 — 105
325,200	{ Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400 }	100	102 — 105	102 — 105	102 — 105
145,300	{ Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	101 — 104	101 — 104	101 — 104
198,200	{ Do. do. do. to bearer, Nos. 2,344 to 5,500 }	100	101 — 104	101 — 104	101 — 104
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8½	8 — 8½	8½
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½	5½
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 23,001 to 70,000	2	4½ — 4½	3½ — 4½	4½ 4
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid (£1½ paid) }	2	1½ — 2½	1½ — 2½	2½
20,000	Fowler-Waring Cables, Nos. 301 to 20,000	5	2½ — 3½	2½ — 3½	3½
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9½	9 — 9½	8½ 8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 15	14½ — 14½	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	16½ 16
15,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104	101 — 104
230,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107	104 — 107
9,334	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½	12½
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11½ — 12½	12½
41,609	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 — 19	18 — 19	18½ 18½
200,000	Do. do. 4½ p. c. Deb., 1896	100	100 — 102	100 — 102	100 — 102
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37	35 — 37
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 (£7 pd.)	10	6½ — 7½	6½ — 7	7
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	6½ — 7½	6½ — 7	7
38,348	London Platino-Brazilian Telegraph, Limited	10	6½ — 7½	6 — 7	7
109,000	Do. do. do. 6 p. c. Debentures	100	105 — 108	105 — 108	105 — 108
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000	10	5½ — 6	6½ — 6½	6½
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4½ — 4½	4½ — 4½	4½ 4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12 — 12½	12½ — 12½	12½
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½ — 10½	9½ — 10½	10½
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8½ — 8½	8½ — 8½	8½
9,000	Reuter's, Limited	8	8½ — 8½	8½ — 8½	8½
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	1	1 — 3	1 — 3	3
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3	3
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117	113 — 117
78,949	Swan United Electric Light, Limited	5	5 — 5½	5 — 5½	5½
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	45 44½
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	100½
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	4
146,128	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 94	90 — 95	90 — 95
3,200	Do. do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½ — 9½	8½ — 9½	9½
290,900	Do. do. do. 5 p. c. Debentures	100	98 — 101	98 — 101	101
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	5
150,000	Do. do. do. 8 p. c. Debs, repay. 1902	100	102 — 107	102 — 107	102 — 107
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	10½ — 11	11½ 10½
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 6½	6½ — 6½	6½
27,873	Do. do. do. 5 p. c. Deferred	7½	4½ — 5	4½ — 5	5
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106	103 — 106
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106	103 — 106
88,321	West India and Panama Telegraph, Limited	10	3½ — 3½	3 — 3½	3½ 2½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 12	11½ — 11½	11½ 11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	14 — 15	11 — 12	11 — 12
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 127	120 — 125	120 — 125
175,100	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103	99 — 103
42,853	*Westmstr. Elcc. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 3	2½ — 3	3

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, 15s. paid), 2—2½.—House-to-House Company (£5 paid), 4½—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 2½—2½.—Manchester Edison and Swan Company, £3 (£1 paid) 11/-—13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2½—3.—Preference, 4½—4½.

BANK RATE OF DISCOUNT.—6 per cent. (7th November 1890).

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 603.)

LECTURE III.—DELIVERED FEBRUARY 3RD, 1890.

## SPECIAL DESIGNS.

In continuation of my lecture of last week, I have to make a few remarks before entering upon the consideration of special forms of magnets, which was to form the entire topic of to-night's lecture. I had not quite finished the experimental results which related to the performance of magnets under various conditions. I had already pointed out that where you require a magnet simply for holding on to its armature, common sense (in the form of our simplest formula) dictated that the circuit of iron should be as short as was compatible with getting the required amount of winding upon it. That at once brings us to the question of the difference in performance of long magnets and short ones. Last week we treated that topic so far as this, that if you require your magnet to attract over any range across an air space, you required a sufficient amount of exciting power in the circulation of electric current to force the magnetic lines across that resistance, and therefore you required length of core in order to get the required coil wound upon the magnetic circuit. But there is one other way in which the difference of behaviour between long and short magnets—I am speaking of horse-shoe shapes—comes into play. So far back as 1840, Ritchie found that it was more difficult to magnetise steel magnets (using for that purpose electro-magnets to stroke them with) if those electro-magnets were short than if they were long. He was, of course, comparing magnets which had the same tractive power, that is to say, presumably had the same section of iron magnetised up to the same degree of magnetisation. This difference between long and short cores is obviously to be explained on the same principle as the greater projecting power of the long-legged magnets. In order to force magnetism not only through an iron arch but through whatever is beyond, which has a lesser permeability for magnetism, whether it be an air gap or an arch of hard steel destined to retain some of its magnetism, you require magnetomotive force enough to drive the magnetism through that resisting medium; and, therefore, you must have turns of wire; that implies that you must have length of leg on which to wind those turns. Ritchie also found that the amount of magnetism remaining behind in the soft iron arch, after turning off the current, at the first removal of the armature, was a little greater with long than with short magnets; and, indeed, it is what we should expect now, knowing the properties of iron, that long pieces, however soft, retain a little more—have a little more memory, as it were, of having been magnetised—than short pieces. Later on I shall have specially to draw your attention to the behaviour of short pieces of iron which have no magnetic memory.

## WINDING OF THE COPPER.

I now take up the question of winding the copper wire upon the electro-magnet. How are we to determine beforehand the amount of wire required, and the proper gauge of wire to employ?

The first stage of such a determination is already accomplished; we are already in possession of the formulæ for reckoning out the number of ampère turns of excitation required in any given case. It remains to show how from this to calculate the amount of bobbin space, and the quantity of wire to fill it. Bear in mind that a current of ten ampères (i.e., as strong as that used for a big arc light) flowing once around the iron, produces exactly the same effect magnetically as a current of one ampère flowing around ten times or as a current of only one-hundredth part of an ampère flowing around a thousand times. In telegraphic work the currents ordinarily used in the lines are quite small, usually from five to twenty thousandths of an ampère; hence in such cases the wire that is wound on need only be a thin one, but it must have a great many turns. Because it is thin and has a great many turns, and is consequently a long wire, it will offer a considerable resistance. That is no advantage, but does not necessarily imply any greater waste of energy than if a thicker coil of fewer turns were used with a correspondingly larger current. Consider a very simple case. Suppose a bobbin is already filled with a certain number of turns of wire, say 100, of a size large enough to carry one ampère, without over-heating. It will offer a certain resistance, it will waste a certain amount of the energy of the current, and it will have a certain magnetising power. Now suppose this bobbin to be re-wound with a wire of half the diameter; what will the result be? If the wire is half the diameter it will have one quarter the sectional area, and the bobbin will hold four times as many turns (assuming insulating materials to occupy the same percentage of the available volume). The current which such a wire will carry will be one-fourth as great. The coil will offer sixteen times as much resistance, being four times as long and of one-fourth the cross section as the other wire. But the waste of energy will be the same, being proportional to the resistance and to the square of the current; for  $16 \times \frac{1}{16} = 1$ . Consequently the heating effect will be the same. Also the magnetising power will be the same, for though the current is only one-quarter of an ampère, it flows around four hundred turns;

the ampère turns are one hundred, the same as before. The same argument would hold good with any other numerical instance that might be given. It therefore does not matter in the least to the magnetic behaviour of the electromagnet whether it is wound with thick wire or thin wire, provided the thickness of the wire corresponds to the current it has to carry, so that the same number of watts of power are spent in heating it. For a coil wound on a bobbin of given volume the magnetising power is the same for the same heat waste. But the heat waste increases in a greater ratio than the magnetising power, if the current in a given coil is increased; for the heat is proportional to the square of the current and the magnetising power is simply proportional to the current. Hence it is the heating effect which in reality determines the winding of the wire. We must—assuming that the current will have a certain strength—allow enough volume to admit of our getting the requisite number of ampère turns without overheating. A good way is to assume a current of one ampère while one calculates out the coil. Having done this, the same volume holds good for any other gauge of wire appropriate to any other current. The terms "long-coil" magnet and "short-coil" magnet are appropriate for those electromagnets which have, respectively, many turns of thin wire and few turns of thick wire. These terms are preferable to "high resistance" and "low resistance," sometimes used to designate the two classes of windings, because, as I have just shown, the resistance of a coil has in itself nothing to do with its magnetising power. Given the volume occupied by the copper, then for any current density (say, for example, a current density of 2,000 ampères per square inch of cross section of the copper), the magnetising power of the coil will be the same for all different gauges of wire. The specific conductivity of the copper itself is of importance; for the better the conductivity, the less the heat waste per cubic inch of winding. High conductivity copper is therefore to be preferred in every case.

Now the heat which is thus generated by the current of electricity raises the temperature of the coil (and of the core), and it begins to emit heat from its surface. It may be taken as a sufficient approximation that a single square inch of surface, warmed  $1^{\circ}$  Fahr. above the surrounding air, will steadily emit heat at the rate of  $\frac{1}{255}$  of a watt. Or, if there is provided only enough surface to allow of a steady emission of heat at the rate of 1 watt\* per sq. inch of surface, the temperature of that surface will rise to about  $225^{\circ}$  Fahr. above the temperature of the surrounding air. This number is determined by the average emissivity of such substances as cotton, silk, varnish, and other materials of which the surfaces of coils are usually composed.

In the specifications for dynamo machines, it is usual to lay down a condition that the coils shall not heat more than a certain number of degrees warmer than the air. With electro-magnets it is a safe rule to say that no electro-magnet ought ever to heat up to a temperature more than  $100^{\circ}$  Fahr. above the surrounding air. In many cases it is quite safe to exceed this limit.

The resistance of the insulated copper wire on a bobbin may be approximately calculated by the following rule. If  $d$  is the diameter of the naked wire, in mills, and  $D$  is the diameter, in mills, of the wire when covered, then the resistance per cubic inch of the coil will be:—

$$\text{Ohms per cub. inch} = \frac{960,700}{D^2 + d^2}$$

We are therefore able to construct a wire gauge and ampère table which will enable us to calculate readily the degree to which a given coil will warm when traversed by a given current, or conversely what volume of coil will be needed to provide the requisite circulation of current without warming beyond any prescribed excess.

Accordingly, I here give a *Wire-Gauge and Ampère Table*, which we have been using for some time at the Finsbury Technical College. It was calculated out under my instructions by one of the Demonstrators of the College, Mr. Eustace Thomas, to whom I am indebted for the great care bestowed upon the calculations.

For many purposes, such as for use in telegraphs and electric bells, smaller wires than any of those mentioned in the table are required. The table is, in fact, intended for use in calculating magnets in larger engineering work.

A rough and ready rule sometimes given for the size of wire is to allow  $\frac{1}{1000}$  square inch per ampère. This is an absurd rule, however, as the figures in the table show. Under the heading 1,000 ampères to square inch, it appears that if a No. 18 S.W.G. wire is used, it will at that rate carry 1.81 ampères; that if there is only one layer of wire, it will only warm up  $4.64^{\circ}$  Fahr., consequently one might wind layer after layer to a depth of 3.3 inches, without getting up to the limit of allowing one square inch per watt, for the emission of heat. In very few cases does one want

\* The watt is the unit of rate of expenditure of energy, and is equal to ten million ergs per second, or to  $\frac{1}{746}$ th of a horse-power. A current of one ampère, flowing through a resistance of one ohm, spends energy in heating at the rate of one watt. One watt is equivalent to 4.2 calories per second, of heat. That is to say, the heat developed in one second, by expenditure of energy at the rate of one watt, would suffice to warm one gramme of water through  $4.2$  (Centigrade) degrees. As 252 calories are equal to one British (lb. Fahrenheit) unit of heat, it follows that heat emitted at the rate of one watt would suffice to warm  $17\frac{1}{2}$  pounds of water one degree Fahrenheit in one minute; or one British unit of heat equals 1,058 watt-seconds.

\* Cantor Lecture. Delivered before the Society of Arts, January 27th, 1890.

TABLE X.—WIRE GAUGE AND AMPERAGE TABLE.

Dimensions.					Permissible ampère, probable heating, and permissible depth.											
S.W.G.	Diam. (inch.)	Section. (sq. inch bare.)	Turns to 1 linear inch. (coverd.)	Turns per sq. inch. (coverd.)	At 1,000 amps. to sq. inch.			At 2,000 amps. to sq. inch.			At 3,000 amps. to sq. inch.			At 4,000 amps. to sq. inch.		
					A	F	D	A	F	D	A	F	D	A	F	D
22	·028	·00062	23·81	624	·616	2·28	4·5	1·23	9·12	1·13	1·85	20·52	·50	2·46	36·5	·28
20	·036	·0010	20·00	440	1·018	3·18	3·9	2·036	12·72	·97	3·05	28·62	·43	4·07	50·9	·24
19	·040	·0012	18·52	377	1·26	3·56	3·6	2·52	14·24	·92	3·78	32·04	·41	5·04	57·0	·23
18	·048	·0018	16·13	286	1·81	4·64	3·3	3·62	18·56	·83	5·43	41·76	·37	7·24	74·2	·21
17	·056	·0024	14·28	224	2·4	5·47	3·2	4·8	21·9	·79	7·2	49·2	·35	9·6	87·5	·19
16	·064	·0032	12·83	181	3·2	6·57	3·0	6·4	26·3	·74	9·6	59·1	·33	12·8	105·1	·18
15	·072	·0040	11·63	149	4·0	7·40	2·9	8·0	29·6	·72	12·0	66·6	·32	16·0	118·4	·17
14	·080	·0050	10·64	124	5·0	8·46	2·8	10·0	33·8	·70	15·0	76·3	·31	20·0	135·4	·17
13	·092	·0060	9·44	98·2	6·6	9·97	2·7	13·2	39·9	·67	19·8	89·7	·30	26·4	159·5	·16
12	·194	·0085	8·48	79·1	8·5	11·53	2·6	17·0	46·1	·65	25·5	103·8	·29	34·0	184·4	·16
11	·116	·0105	7·69	65·0	10·5	12·8	2·5	21·0	51·2	·63	31·5	115·2	·28	42·0	204·8	·16
10	·128	·0128	7·04	54·5	12·8	14·3	2·4	25·6	57·2	·61	38·4	128·7	·27	51·2	228·8	·15
9	·144	·0163	6·33	44·1	16·3	16·4	2·4	32·6	65·6	·60	48·9	147·6	·27	65·2	262·4	·15
8	·160	·0201	5·74	36·3	20·1	18·4	2·3	40·2	73·6	·59	60·3	165·6	·26	80·4	294·4	·15
7	·176	·0243	5·26	30·4	24·3	20·4	2·3	48·6	81·6	·58	72·9	183·6	·26	97·2	326·4	·15
Stranded.																
7/22	·084	·0043	9·62	101·8	4·3	6·73	4·0	8·6	26·9	·99	12·9	24·6	·44	17·2	107·7	·25
7/20	·108	·0072	7·81	67·1	7·13	8·94	3·7	14·3	35·7	·92	21·4	80·5	·48	28·5	143·0	·23
7/18	·144	·0128	6·09	40·8	12·7	12·4	3·4	25·4	49·6	·83	38·1	111·6	·39	50·8	198·4	·21
7/16	·192	·0229	5·10	28·6	22·9	17·2	3·2	45·8	68·7	·79	68·7	154·5	·35	91·6	274·7	·20
7/15	·216	·0289	4·27	20·1	28·9	19·5	3·1	57·8	78·0	·78	86·7	175·4	·34	115·6	311·8	·20
7/14	·240	·0356	3·87	16·5	35·6	21·8	3·1	71·2	87·1	·76	106·8	195·9	·34	142·4	348·3	·19
7/13	·276	·0462	3·38	12·6	46·2	24·7	3·0	92·4	98·8	·74	138·6	222·3	·33	184·8	395·2	·19
7/12	·312	·0595	3·01	9·97	59·5	28·5	2·9	179·0	114·0	·72	178·5	256·5	·32	238·0	456	·18

Figures in columns marked A signify number of ampères that the wire carries.

Figures in columns marked F signify number of degrees (Fahr.) that the coil will warm up if there is only one layer of wire, and on the assumption that the heat is radiated only from the outer surface of the coil: they are calculated by the following modification of Forbes's rule:—

Rise in temperature (Fahrenheit degrees)

=  $225 \times \text{No. of watts lost per sq. inch.}$

=  $159 \times \text{sectional area} \times \text{number of turns to 1 inch (at 1,000 amps. per sq. inch.)}$

Figures in columns marked D are the depths in inches to which wire may be wound if one watt be lost by each square inch of radiating surface, the outside radiating surface of the bobbin being only considered.

Rule for calculating a 7-strand cable:—Diam. of cable =  $1 \cdot 134 \times \text{by diam. of equivalent round wire.}$

Figures under heading "Turns to 1 linear inch" are calculated for cotton-covered wires of average thicknesses of coverings used for the different gauges, viz., 14 mils additional diameter on round wires (from No. 22), and 20 mils on stranded or square wire.

Figures under heading "Turns per sq. inch" are calculated from preceding, allowing 10 per cent. for bedding of layers.

Resistance (ohms) of coil of copper wire, occupying  $v$  cubic inches of coil-space, and of which the gauge is  $d$  mils uncovered, and  $D$  mils covered, may be approximately calculated by the rule:—

$$\text{ohms} = 960,700 \frac{v}{D^2 d^2}$$

The data respecting sizes of wires of various gauges are kindly furnished by the London Electric Wire Company.

to wind a coil so thick as 3·3 inches. For very few electro-magnets is it needful that the layer of coil should exceed  $\frac{1}{2}$  an inch in thickness; and if the layer is going to be only  $\frac{1}{2}$  an inch thick, or about  $\frac{1}{3}$ th of the 3·3, one may use a current density  $\sqrt{7}$  times as great as 1,000 ampères per square inch, without exceeding the limit of safe working. Indeed, with coils only  $\frac{1}{2}$  inch thick, one may safely employ a current density of 3,000 ampères per square inch, owing to the assistance which the core gives for the dissipation and emission of heat.

Suppose, then, we have designed a horse-shoe magnet, with a core 1 inch in diameter, and that after considering the work it has to do, it is found that a magnetising power of 2,400 turns is required; suppose, also, that it is laid down as a condition that the coil must not warm up more than 50° Fahr. above the surrounding air—what volume of coil will be required? Assume first that the current will be 1 ampère; then there will have to be 2,400 turns of a wire which will carry 1 ampère. If we took a No. 20 S.W.G. wire, and wound it to a depth of  $\frac{1}{2}$  an inch, that would give 220 turns per inch length of coil: so that a coil 11 inches long, and a little over  $\frac{1}{2}$  inch deep (or 10 layers deep) would give 2,400 turns. Now Table X. shows that if this wire were to carry 1·018 ampère, it would heat up 225° Fahr., if wound to a depth of 3·9 inches. If wound to  $\frac{1}{2}$  inch, it would therefore heat up about 30° Fahr.; and with only 1 ampère would of course heat less. This is too good; try the next thinner wire. No. 22, S.W.G. wire, at 2,000 ampères to square inch, will carry 1·23 ampères; and heats 225° if wound up 1·13 inches. If it is only to heat 50° it must not be wound more than  $\frac{1}{2}$  inch deep; but if it only carries current of 1 ampère it may be wound a little deeper—say to 14 layers. There will then be wanted a coil about 7 inches long to hold the 2,400 turns. The wire will occupy about 3·85 square inches of total cross section; and the volume of the space occupied by the winding will be 26·95 cubic inches. Two bobbins, each 3 $\frac{1}{4}$  inches long and ·65 deep, to allow for 14 layers, will be suitable to receive the coils.

By the light of the knowledge one possesses as to the relation between emissivity of surface, rate of heating by current, and limiting temperatures, it is seen how little justification there is for such empirical rules as that which is often given, namely, to make the depth of coil equal to the diameter of the iron core. Consider this in relation to the following fact; that in all those

cases where leakage is negligible, the number of ampère turns that will magnetise up a thin core to any prescribed degree of magnetisation will magnetise up a core of any section whatever, and of the same length, to the same degree of magnetisation. A rule that would increase the depth of copper proportionately to the diameter of the iron core is absurd.

Where less accurate approximations are all that is needed, more simple rules can be given. Here are two cases:—

Case 1. Leakage assumed to be negligible.—Assume  $B = 16,000$ , then  $H = 50$  (see Table III). Hence the ampère turns per centim. of iron will have to be 40, or per inch of iron, 102; for  $H$  is equal to 1·2566 times the ampère turns per centimetre. Now if the winding is not going to exceed  $\frac{1}{2}$ -inch in depth, we may allow 4,000 ampères per square inch without serious overheating. And the 4,000 ampère turns will require 2-inch length of coil, or each inch of coil carries 2,000 ampère turns without overheating. Hence each inch of coil  $\frac{1}{2}$ -inch deep will suffice to magnetise up 20 inches length of iron to the prescribed degree.

Case 2. Leakage assumed to be 50 per cent.—Assume  $B$  in air gap =  $H = 8,000$ , then to force this across requires ampère turns 6,400 per centim. of air, or 16,250 per inch of air. Now if winding is not going to exceed  $\frac{1}{2}$ -inch depth, each inch length of coil will carry 2,000 ampère turns. Hence, 8 inches length of coil  $\frac{1}{2}$ -inch deep will be required for one inch length of air, magnetised up to the prescribed degree.

#### WINDINGS FOR CONSTANT PRESSURE AND FOR CONSTANT CURRENT.

In winding coils for magnets that are to be used on any electric light system, it should be carefully borne in mind that there are separate rules to be considered according to the nature of the supply. If the electric supply is at constant pressure, as usual for glow lamps, the winding of coils of electro-magnets follows the same rule as the coils of voltmeters. If the supply is with constant current, as usual for arc lighting in series, then the coils must be wound with due regard to the current which the wire will carry, when lying in layers of suitable thickness, the number of turns being in this case the same whether thin or thick wire is used.

If we assume that a safe limit of temperature is 90° Fahr. higher than the surrounding air, then the largest current which

may be used with a given electro-magnet is expressed by the formula:—

$$\text{Highest permissible ampères} = 0.63 \sqrt{\frac{s}{r}}$$

where  $s$  is the number of square inches of surface of the coils, and  $r$  their resistance in ohms.

Similarly for coils to be used as shunts we have:—

$$\text{Highest permissible volts} = 0.63 \sqrt{sr}$$

The magnetising power of a coil, supplied at a given number of volts of pressure, is independent of its length, and depends only on its gauge, but the longer the wire the less will be the heat waste. On the contrary, when the condition of supply is with a constant number of ampères of current, the magnetising power of a coil is independent of the gauge of the wire, and depends only on its length; but the larger the gauge the less will be the heat waste.

#### MISCELLANEOUS RULES ABOUT WINDING.

To reach the same limiting temperature with bobbins of equal size wound with wires of different gauge, the cross-section of the wire must vary with the current it is to carry; or, in other words, the current density (ampères per square inch) must be the same in each. Table X. shows the ampérages of the various sizes of wires, at four different values of current density.

To raise to the same temperature two similarly shaped coils, differing in size only, and having the gauges of the wires in the same ratio (so that there are the same number of turns on the large coil as on the small one), the currents must be proportional to the square roots of the cubes of the linear dimensions.

Sir William Thomson has given a useful rule for calculating windings of electro-magnets of the same type but of different sizes. Similar iron cores, similarly wound with lengths of wire proportional to the squares of their linear dimensions, will, when excited with equal currents, produce equal intensities of magnetic field at points similarly situated with respect to them.

Similar electro-magnets of different sizes must have ampère-turns proportional to their linear dimensions if they are to be magnetised up to an equal degree of saturation.

It is curious what erroneous notions crop up from time to time about winding electro-magnets. In 1869, a certain Mr. Lyttle took out a patent for winding the coils in the following way. Wind the first layer as usual, then bring the wire back to the end where the winding began and wind a second layer, and so on. In this way all the windings will be right-handed, or else all left-handed, not alternately right and left as in the ordinary winding. Lyttle declared that this method of winding a coil gave more powerful effects; so did M. Brisson, who re-invented the same mode of winding in 1873, and solemnly described it. Its alleged superiority was at once disproved by Mr. W. H. Preece, who found the only difference to be that there was more difficulty in carrying out this mode of winding.

Another popular error is that electro-magnets in which the wires are badly insulated are more powerful than those in which they are well insulated. This arose from the ignorant use of electro-magnets having long thin coils (of high resistance) with batteries consisting of a few cells (of low electromotive force). In such cases, if some of the coils are short-circuited, more current flows, and the magnetising power may be greater. But the scientific cure is either to rewind the magnet with an appropriate coil of thick wire, or else to apply another battery having an electromotive force that is greater.

(To be continued.)

#### NEW PATENTS—1890.

17165. "A process for producing copper blocks with steel core for the manufacture of telegraph and telephone wire." H. LOHAUSEN. Dated October 27.

17181. "Improved electric switch." H. J. ALLISON. (Communicated by J. A. K. McGregor, H. Wallach, and S. J. Wallach, United States.) Dated October 28. (Complete.)

17247. "Improvements in electric apparatus for transmitting motion." M. W. DEWEY. Dated October 28. (Complete.)

17277. "An improved method of and apparatus for the electrical treatment of sewage, wines, oils, air, gases, and other fluids." R. WOTHERSPOON. (Communicated by H. Rowley, Australia.) Dated October 29.

17308. "Improved switch for electric light." C. W. COX and F. ROBINSON. Dated October 29.

17375. "An electric motor." J. B. DENIS. Dated October 30.

17394. "Apparatus for effecting a permanent make or break of an electric circuit at any suitable number of points." L. V. CHABRAND. Dated October 30.

17459. "Improvements in and relating to electric arc lamps." F. V. MAQUAIRE. Dated October 31.

17558. "Portable generator and electrometer for testing insulation resistance of electric wires." J. J. RATHBONE. Dated November 1.

17560. "Improvements in and relating to locked switches for electric current circuits." J. A. ILIFFE and H. BARTON. Dated November 1.

#### ABSTRACTS

#### OF PUBLISHED SPECIFICATIONS 1889.

14860. "Improvements in automatic telephone devices." C. G. HOFFMANN. Dated September 20. 11d. Consists in the main of the speaking apparatus, of the mechanism for examining the coin and of the box, and consists in the combination of a telephone system with a coin examining apparatus and a clock mechanism situated in the exchange station in such a manner, that by the insertion of a certain coin into the apparatus a draw rod is released and by pulling the same by means of lever connections the telephones are liberated so that a call is automatically effected to the exchange station, which establishes the desired connection with the public speaking station which is then connected with the wire of the subscriber by the pressure of a button and at the same time causing the stoppage of a wheel moved by a clock mechanism during any desired interval (5 minutes) by a lever which at the termination of this time, raised by another lever, establishes again the earth connection and thus interrupts automatically the connection of the public speaking station with the subscriber. 6 claims.

15609. "Improved electrical railway switch and signal apparatus." F. X. BACHMANN. Dated October 4. 8d. Includes a system of signals electrically operated in conjunction with the points from the same station. 4 claims.

17124. "Improvements in interrupting devices for electric circuits, applicable for protecting electrical apparatus connected in such circuits." W. P. THOMPSON. (A communication from abroad by the Westinghouse Electric Company of America.) Dated October 29. 8d. Consists in forming a shunt circuit around a fusible strip, so constructed as to receive the entire current immediately upon the destruction of the fusible strip and then itself become interrupted in such a manner as to form an opening of the circuit. 3 claims.

17274. "An electric switch." G. S. GRIMSTON. (Partly communicated from abroad by F. Jacob.) Dated October 31. 6d. The inventor provides a ratchet wheel having an even number of teeth, which are alternately of conducting and of insulating material or are faced with such material, all the conducting parts being connected to the one wire of the circuit. A metallic spring pawl which is connected to the other wire of the circuit bears against the ratchet wheel, which is otherwise insulated from the pawl. On turning the wheel by hand partly round the pawl is first strained against its spring and then jumps rapidly from one tooth to the next, making or breaking contact as the case may be, and then holding the wheel steadily in position and preventing it from being turned backwards. 1 claim.

17694. "An electrical watt meter." E. WILSON. Dated November 6. 8d. The inventor applies an automatic break solenoid, excited by the current or a known fraction thereof, to give reciprocation to an anchor acting on an escapement wheel to cause a spindle to revolve at a speed which is proportional to the electromotive force or volts of the exciting current. The spindle drives a disc or cone, and also by means of a bevil wheel drives two opposite bevil pinions which are free on a transverse spindle, but either of which can be clutched to the transverse spindle by a clutch sleeve sliding between them. This clutch sleeve is connected to an armature between two electro-magnets, or to the core of a solenoid subject to the strain of a spring, so that according as the one or the other of the two electro-magnets is excited or according as the solenoid is excited or not, the clutch is moved so as to engage the one or the other of the two bevil pinions to the transverse spindle, causing that spindle to rotate in the one direction or the other. 2 claims.

17831. "Improvements in electric battery carbon and carbon compound elements and their connections." J. V. SHERRIN. Dated November 8. 6d. The inventor connects and prepares the carbon or carbon compound elements for primary and other electric batteries in the following manner: In that part of the upper edge of the carbon where the connection is to be made he laps it round with a piece of sheet platinum or platinum foil upon which he places a brass clamp or other connection for the wire. The clamp may be fixed by means of a screw the point of which bears on an interposed copper plate. To the clamp he connects the wire by soldering or by a terminal screw. The upper part of the carbon element is then covered with shellac to a depth of about an inch or two down from the top. 3 claims.

18159. "Improvements in electric contact apparatus, chiefly designed for indicating the level of water in reservoirs, the movement of hauling drums, lifts, and the like." C. WEUSTE. Dated November 13. 8d. Comprises a disc having in or upon it one or more teeth, which disc is in the first place caused to turn by the float of a water reservoir or by the machine or other device to be controlled. By this means a pin, acted upon by a weight or a comparatively heavy ball, is carried away. As soon as the aforesaid tooth has been turned far enough it releases the ball or the pin whereupon the latter by reason of its weight or the action of the spring will move upon a suitable guide back to its original position, making contact at the same time. 2 claims.

18980. "Improved means of suspending electric lamps and other suspended objects." W. F. BEADNEE. Dated November 26. 8d. Consists in the interposition, in the suspension cord or cable, of a differential pulley, windlass, or drum having peripheries of

two diameters, from one of which the cable extends to the ceiling or other point of support, and from the other of which the cord or cable descends to the lamp, the differential pulley (with or without a case) forming a weight which, when the lamp is lifted, gravitates, and in unrolling the cord from the smaller pulley rolls up the slack on to the larger pulley, the balancing effect of the two pulley surfaces serving to hold the lamp at any point to which it may be adjusted. 8 claims.

19195. "Improvements in and relating to the laying of electric and other wires in streets and roads." R. SUMMERS. Dated November 29. 6d. The inventor forms the curb of the pathway hollow and of suitable material, such as cast iron, the cross section being the same as the present curb but considerably deeper. The sections are made in suitable lengths and are jointed together in any known manner. Where the wires have to cross a road, elbows are provided so as to obtain the different level between the footpath and the roadway. Openings, closed by suitable lids or doors, are provided at suitable distances apart in order to allow of easily getting at the wires and suitable connections are provided to allow of the wires being conducted to the buildings in the street or road where required. 3 claims.

## 1890.

1878. "Improvements in electric insulating compounds." J. B. WILLIAMS. Dated February 4. 6d. Consists, briefly, in the combination with India-rubber and paraffin wax of a resinous body and sulphur, to which may be added what may be designated as inert material which serves to harden the compound and lessen its cost. 5 claims.

3484. "Improved electrical secondary clockwork." E. SCHWEIZER. Dated March 4. 6d. Consists in the employment of a lever to which a reciprocating motion is imparted by the combined influence of a horizontal electro-magnet and of a spring, and which on the one hand operates by means of a pawl upon a toothed wheel on the minute arbor, and on the other hand acts by means of a rod upon a special escapement device, which in its turn acts upon the said toothed wheel, so that the number of wheels of the electrical secondary clock can be limited to that of the minute and hour wheels of an ordinary clock dial. 2 claims.

3419. "Method of and apparatus for producing and utilising pulsating electric currents in closed circuits." C. J. VAN DEPOELE. Dated March 4. 11d. Comprises means for producing electric currents having a defined rise and fall being thereby rendered intermittent or pulsating, means for varying the rate of succession of said currents, together with both rotary and reciprocating engines particularly adapted to be operated with currents produced according to my said invention, the said defined currents being moreover utilised in closed working circuits so that their characteristic qualities are not due to the use of circuit-breaking devices, upon all of which my present invention is an improvement. 5 claims.

## CORRESPONDENCE.

## Alternating Current Meters.

In your issue of October 10th, I find a letter of Mr. Arthur Wright on the subject of alternating current meters, which, on account of the writer and the contents, I cannot pass without notice. You will greatly oblige me therefore, if you will kindly insert in your columns the following few lines.

I regret that various reasons prevent me to speak without restriction on the subject as I would desire, but perhaps few words will be sufficient to show Mr. Wright that he is unacquainted with the real state of the things.

My patents—it will be remembered—appeared 1st of May, 1888, and nearly at the same time the results of Prof. Ferraris were published in *Industries*, disclosing the same invention. Once the invention was known it required but little inventive spirit to make experiments and modifications, which sooner or later must suggest themselves to every intelligent worker, and it is needless to say that the experiments referred to by Mr. Wright were performed by me at a much earlier period, and an application covering broadly the principle of operating a motor by passing an alternating current through a circuit, and inducing currents by the same in other parts or closed circuits, was filed by me long before I read my paper and showed some of my motors before the American Institute of Electrical

Engineers, in May 1888. I was, however, at that time, not at liberty to speak on this and other matters which would have rendered my paper more valuable and interesting.

Nothing was known through the journals of this invention until Schallenger's patent on the meter appeared, I believe in June, 1888, where a motor on this principle was shown in combination with a registering and retarding device. Besides some forms of motors constructed by me and based on the principle of magnetic lag and screening—which were somewhat novel features—nothing new was shown in the way of a commutatorless motor, which would not be comprised within the scope of the inventions of Prof. Ferraris, Schallenger and myself.

Mr. Wright states that I am wrong in attributing the rotation in his meter to the same cause as that in Schallenger's. I have conceived the theory of these phenomena and confirmed it by many experiments. I have been familiar with them long in advance of anything published on that subject, and have utilised the principle underlying them in many forms of practical motors; I therefore think that I am not mistaken. In Schallenger's meter a current is passed through one circuit and currents are induced in other circuits, and the poles are shifted; is not the same the case in Wright's meter? As regards the motive devices invented by Messrs. Borel and Piccaud, to which Mr. Wright refers, he makes me a high compliment, for motors on that principle were among the first which I have devised and operated, and not only have I devised many forms of these motors, but I have also shown, nearly three years ago, that in accordance with my theory of the action of the motors, a rotation in opposite direction may be produced under certain conditions.

Nikola Tesla.

November 7th, 1890.

## High-handed Proceedings.

Mr. A. Erskine Muirhead has asked us to insert the following correspondence:—

Mr. James Richmond, Baker,  
John Finnie Street, Kilmarnock.

22, Castle Street, Edinburgh,  
4th November, 1890.

SIR,—We act for the United Telephone Company of London, and have to-day received instructions to adopt proceedings against your infringing certain patent rights belonging to them. We are informed that you have recently fitted up and are using four Ader receivers, which are infringements of their patent, and our instructions are forthwith to raise an action for interdict, damages, delivery of the instruments and costs. Before doing so, we write to give you intimation of this and an opportunity of delivering up the four infringing instruments. If these are delivered to us here *complete* in the course of *to-morrow*, we shall refrain from instituting legal proceedings. If they are not, proceedings will be at once instituted without further notice.

We also beg to request you to inform us who supplied you with the instruments; and, in your own interest, to warn you against delivering them over to any one except our clients or us.

We are, your obedient Servants,

DAVIDSON & SYME.

Glasgow, 6th November, 1890.

Messrs. Davidson and Syme,  
22, Castle Street, Edinburgh.

Gentlemen,—Your favour of 4th inst., addressed to Mr. Jas. Richmond, Kilmarnock, has been handed to me, asking me to write you and also for my advice. I may at once say I take all responsibility upon myself, and when fitting up the telephones, told Mr. Richmond

that they did not infringe any of the patents held by the National Telephone Coy., Ltd., or the United Telephone Coy., Ltd.; I again assert this. The telephone in question will not be removed nor handed to you, but to show that I am more magnanimous than your clients, I am willing to allow your electric engineer, Mr. Aitken, to go with my man and inspect the telephones for himself in your client's interest.

It will help to clear the matter when I inform you that they are the English type of telephones in French cases, and this is the reason, I presume, that your zealous employés jumped to the conclusion that they were the celebrated "Ader" telephones that have given your president, Col. Jackson, and William Alexander Smith, Esq., chairman of Local Board, so much anxiety of late. I hear that your employés entered the premises of Mr. Richmond; this, if not a criminal is an illegal act, and whether the telephones are infringements or not, it will fall to your party to conciliate Mr. Richmond in any case.

Your obedient servant,

A. ERSKINE MUIRHEAD.

P.S.—The telephones have Carta (paper) diaphragms, with  $\frac{1}{4}$ " iron armatures and electro-magnets. They have no permanent magnet nor iron diaphragms.

Glasgow, 10th November, 1890.

Messrs. Davidson & Syme,  
22, Castle Street, Edinburgh.

Gentlemen,—Though I wrote you on the 6th curt., I am still without any reply from you or your clients, The National and United Telephone Company, Limited, as to what proposal they have to make regarding their unwarrantable proceedings in interfering with my telephones. I may add that I have consulted the highest authority on telephony in this country, viz., Mr. A. R. Bennett, late manager for Scotland for the National Telephone Coy., Ltd.; you can consult him also, I presume.

Yours truly,

A. E. MUIRHEAD.

Glasgow, 11th November, 1890.

Messrs. Davidson and Syme, Edinburgh.

Gentlemen,—I am still without any reply from you, and as the idea is being spread abroad by your clients, that your clients seized four "Ader" receivers infringing your client's patents, as the said four telephones belong to me, and as before explained to Mr. Alexander Smith, chairman of the Local Board of the N. T. Company, Limited, in a letter dated 4th curt., of which the following is a copy:—

"November 4th, 1890.

"Mr. W. Alex. Smith,  
"6, So. Hanover Street, Glasgow.

"Dear Sir,—I have your favour of date and am sorry you cannot accede to my request.\* I am fitting a number of 'Ader' receiver cases with Carta and English Mechanic diaphragms for exposure in Glasgow and elsewhere. I presume you are aware that those do not infringe any of your patents. I shall have pleasure in giving your engineer an order to inspect them should he think fit.

"Signed A. ERSKINE MUIRHEAD."

Mr. W. A. Smith replies on 6th as follows from Telephone Office:—

Glasgow, November 6th, 1890.

A. Erskine Muirhead, Esq.,  
Cart Forge, Glasgow.

Dear Sir,—On my return from England this morning I find your favour of 4th. As I mentioned to you for-

merly this company is determined to uphold its patents to the last day they run, and it is for you to act so that you do not infringe upon any of our rights. The question, what is or is not an infringement of our patent appliances, is one which the courts alone will decide.

Yours respectfully,

WM. ALEX. SMITH.

Up till this date you have not made any reply to my communications, you will not consider it out of order should I send a copy of this correspondence to the Press.

Yours truly,

A. E. MUIRHEAD.

P.S.—You will please note that I am running bronze wires in England and Scotland for some of the largest manufacturing firms, to which "Ader" telephones will be fixed on the expiry of the telephone patent which occurs in a few days now. To be above board with your clients, I am willing to give you a list of those lines, but repeat I will not remove the telephones in Kilmarnock.

Glasgow Offices, Royal Exchange Buildings,  
11th November, 1890.

A. Erskine Muirhead, Esq.,  
Cart Forge, Crossingloof.

Dear Sir.—Regarding yours of the 4th inst., to Mr. W. A. Smith, we have instructions from our London office for our Mr. Aitken to examine the instruments therein referred to. I will be glad therefore if you will let me know at what time it will be convenient for him to do so.

Yours truly,

F. DOUGLAS WATSON,  
Assistant District Secretary.

Glasgow, November 12th, 1890.

The National Telephone Co., Ltd.,  
Glasgow.

Gentlemen,—Your favour of the 11th is duly to hand, but as your Mr. Alexander Smith had already declined my offer to save you from the undignified position you have now placed yourselves in, not to speak of the position occupied by some of your employés, into whose conduct the criminal authorities are making investigation, it is for your London Office to adopt another mode of procedure.

The instruments will be produced at the proper time and place for inspection by competent authorities.

Don't you think some apology is due to Mr. Richmond for your employés' proceedings?

Yours truly,

A. E. MUIRHEAD.

#### Note on Localisation of Faults in Electric Light Circuits.

The ELECTRICAL REVIEW of October 10th, 1890, describes M. Henri Wilbrant's test for localising an *earth* fault when this occurs in one of a pair of buried leads of equal length and resistance.

Fig. 1 shows M. Wilbrant's method:—Accumulator with one pole earthed joined up through ammeters to looped leads A and B.  $C^1$  and  $C^2$  are deflections on respective ammeters.  $L$  = total length, or total resistance of loop, and  $x$  = distance of fault from test station.

Then  $C^1 : C^2 :: x : L - x$  and  $x = \frac{C^1 L}{C^1 + C^2}$  ohms or

metres, according as  $L$  is in terms of ohms or metres.

The above test, in its electrical development, is an adaptation of May's formula for localising an *earth* fault by the polarisation current emanating from the fault itself.

\* This had reference to a Lacombe cell.

May's test is as in fig. 2, which shows line (L) with fault at F, and earthed at both ends through similar galvanometers,\* the respective deflections of which may be termed  $C^1$  and  $C^2$ . The polarisation currents from

FIG. 1.

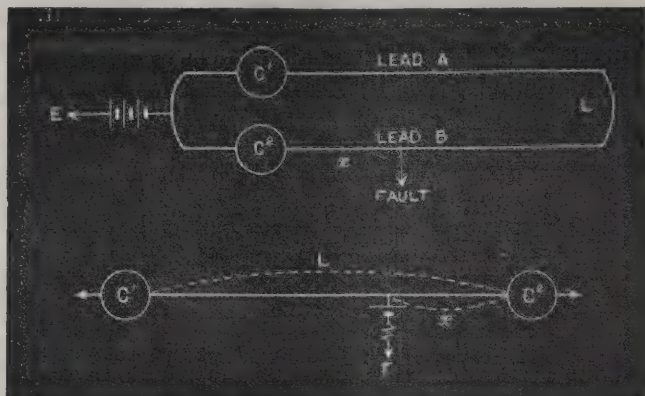


FIG. 2.

F, which flow through the two available branches, are, of course, inversely proportional to the resistances of those branches, so we have  $C^1 : C^2 :: x : L - x$ , and

$$x = \frac{C^1 L}{C^1 + C^2}, \text{ as above.}$$

The following modification of this test, by the writer, is also applicable to M. Wilbrant's method with accumulators and ammeters.

If—in May's test—F be electrically midway between the two galvanometers,  $C^1$  will equal  $C^2$ ; but if, not, then, of course, the galvanometer nearest the fault will give the higher deflection. Then, if the operator whose galvanometer gives the higher deflection, introduce a resistance R, sufficient to bring F electrically midway between the two galvanometers, sufficient—in other words—to make  $C^1 = C^2$  (see fig. 3),

FIG. 3.

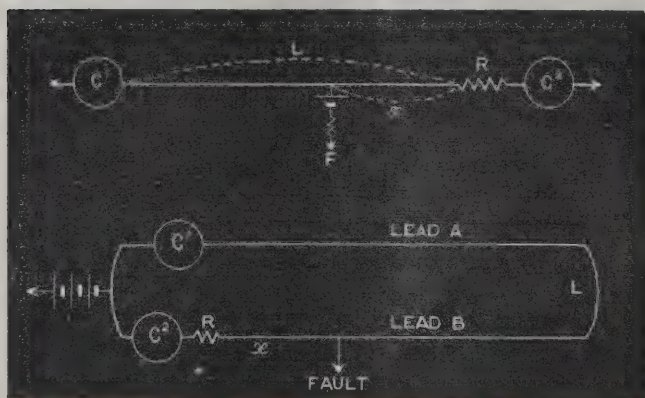


FIG. 4.

we shall have  $C^1 : C^2 :: x + R : L - x$ ;

or,  $C^1 (L - x) = C^2 (R + x)$

and  $x = \frac{C^1 L - C^2 R}{C^1 + C^2}$

but  $C^1 = C^2$ , so  $x = \frac{L - R}{2}$ .

applying the same modification to M. Wilbrant's test, we have (see fig 4) :—

$$C^1 : C^2 :: x + R : L - x, x = \frac{C^1 L - C^2 R}{C^1 + C^2}$$

and if  $C^1 = C^2$ ,  $x = \frac{L - R}{2}$ .

Perhaps this will be found the neater method of the

two, especially if the coils at R (\*) be arranged in resistance units equivalent to metres of line. Then, if  $L$  = total length in metres,

$$\text{Distance of fault} = \frac{L - R}{2} \text{ metres.}$$

Edward Raymond Barker.

B. S. T. Co., Madeira, Nov., 1890.

### The Life of Glow Lamps.

In your Correspondence columns of last week I notice a letter from Mr. Lott on "The Life of Glow Lamps on the Series System."

Before being able to attach any practical value to Mr. Lott's statement, might I ask him to kindly furnish the absolutely necessary figures or approximations as to the watts per C.P. that this lamp required initially and after burning 10,000 hours?

As I have often remarked before, in your columns, such statements of hours burnt, &c., are quite valueless unless C.P. and watt readings are simultaneously given. I believe it quite practicable for either a series or multiple glow lamp to burn considerably over 10,000 hours if always kept at a low enough efficiency, say 5 watts per C.P. and below.

If the particular lamp mentioned by Mr. Lott began at, say, 3 watts per C.P. and after 10,000 hours even went up to 4 watts per C.P., then I should consider that this denoted an excellent result and for practical reasons only would diminish the weight of Mr. Mordey's remarks, although his remarks must remain true in a theoretical sense.

C. J. Robertson,

Middleburg, Holland, November 12th, 1890.

The letter of Mr. Lott, in your issue of the 14th inst., is of interest. But at what efficiency was the particular lamp run? It may have rather a thick carbon which would account for the long life. But the "average life," is more important, with which perhaps your correspondent would favour us, and at the same time any information with regard to the reliability of the cut-out in the lamp would no doubt be of interest to your readers as well as myself.

J. E. Pearce.

November 17th, 1890.

### Telopy or Telephony.

It may appear as though we were looking ahead too much when we discuss the name of that which is at present non-existent. But, as we are told that we should first work out our ideal, and afterwards approach that ideal as nearly as hard circumstances will permit, we may as well act on the same plan in this matter of naming an undiscovered instrument. Now, as words are only symbols to express our thoughts to others by writing or speaking, it is necessary that words, when written or spoken, should express those thoughts as clearly, as shortly, and as euphoniously as possible. The series of words Telopy, a Telopist, the Telope, I Telepe, seem to fulfil the required conditions better than Telephony, a Telephanist, the Telephone, I Telephone. If that which is expressed by these words becomes as common as telegraphy, we shall probably have some totally different word used; just as we have—a wire, and I wire. Meantime, for writing and lecturing purposes, which of the above groups of words shall we employ to express seeing at a distance?

A. C.

November 18th, 1890.

\* If dissimilar galvanometers be used, knowledge of their respective figures of merit would still permit of comparison of deflections.

\* These would be similar in general construction to those used in electric lighting, and in such like heavy work.

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THE ELECTRO-DEPOSITION OF COPPER.

WE call the attention of our readers to the letter from Mr. W. Stepney Rawson, which appears in our correspondence columns.

Mr. Rawson says the eight points in his letter published in our issue of November 7th "remain unanswered," and so he favours us with them all over again. To this we have to say that points 1, 2, and 3 consisted of the respective phrases "practically ridiculous," "equally ridiculous," and "like absurdity." These points were not "answered," though they were not neglected to be noticed. Points 4, 5, 6, 7 and 8 were all dealt with in their order. When Mr. Rawson gives us something other than absurdities and unsupported denunciations we can deal with it, and in his letter which we publish to-day Mr. Rawson does give us something tangible on the first point, which also bears on the second and third. In the calculations which we published on October 17th we allowed for a week of 60 hours, which is a very general basis to take for a week's work. Whether working a larger number of hours is a more economical plan depends largely on the relative importance of labour and plant. There is nothing incorrect about the figures we gave. Contrary to the Elmore plan, we stated clearly and definitely the basis of our calculations, and expressly emphasised their hypothetical character by following them with other data derived from actual work. Mr. Rawson says we should have taken 156 hours. Experience in other cases supports his contention for a larger number of hours per week, and when we make further calculations we will adopt a larger number. If Mr. Rawson will also favour us with his views of the number of tanks which should be taken into consideration, and we find that equally reasonable, we will adopt it, too, together with the further modifications which would then be necessary to arrive at a correct result. He knows well enough, however, that

we were not labouring under the impression that Elmore uses one tank only.

In the calculation referred to we arrived at a figure of 287,620 ampères. Mr. Rawson says these figures are absurd, and should be corrected to 3,000 ampères. Now if these two sets of figures are intended to represent the same thing, it is only necessary to place them in juxtaposition to show there is an absurdity somewhere. What our figures mean, and how they are arrived at, are clearly set forth in every detail. If Mr. Rawson will tell us what his figures mean, and how they are arrived at in similar detail, the absurdity may become apparent. Without attempting to prophesy we think we may say that the probability is the absurdity will be found not in either of the figures but in their comparison. We may here quote for Mr. Rawson's benefit a paragraph in the same article :—"Placing a number of depositing tanks in series would not make matters any better, for what is gained in one respect is lost in another."

These remarks cover Mr. Rawson's first, second, and third points. The fourth point contains a new claim to economy in the Elmore process by the reduced size of tanks necessary. We have no wish whatever to minimise this, or any other, advantage, and if Mr. Rawson will also favour us with particulars of the extent of this economy, we shall be much obliged to him. We have nothing to add to our remarks on horse-power, which is the fifth point. On the sixth point, we have only to say, in addition to what we have said already, that the age of our £12 data is immaterial. Moreover, the Norddeutsche Affinerie, of Hamburg, whose figures, it will be remembered, were the lowest of those quoted on p. 479, and to whom we applied for verification, sends us the following ominous reply :—"We beg to say that the figures in question are incorrect, but we are not willing to rectify them." Reductions, if any, apply generally, and whether £12 or £8 be correct, the Elmore Company will have to deal with the market price, and the market price will be dependent upon competition. The simple

questions are : (a) Can electro-deposited copper compete with copper otherwise prepared, for use under circumstances in which electro-deposition is an unnecessary refinement, or (b) in cases where electro-refining or depositing is advantageous, are the economies of the Elmore process such as will enable the company to undersell everybody else in the market, and still pay a dividend on the purchase price of the patents? The further question of the protection afforded by the said patents is, of course, very material, though in a different category. On the seventh point, we must ask Mr. Rawson not to make too much of our disclaiming any intention to reflect upon the quality of the articles produced. We did so simply in accordance with our usual custom not to express an opinion without due consideration. It will be time enough to commend or condemn the quality of the articles when they are in the market. The eighth point brings us to the report of Mons. Secretan, with which we consider it necessary to deal somewhat fully. Before we do so, we may remind Mr. Rawson that we have been through his points, number by number. If there is still something we have left unsaid, he will doubtless remind us of it. In such an event, may we suggest to him that in controversial discussions there is some danger of losing sight of the main point by enlarging on side issues. We have no intention of permitting this to be done if we can avoid it. Therefore, perhaps Mr. Rawson, in any future communication, will bear in mind that the questions of real importance are those we have asked in reference to point six.

The report of Mons. Secretan, as presented to his directors, contained a statement of the cost of production, and the prices to be realised. This would have helped materially to the elucidation of the questions we have propounded, but unfortunately it is represented in our copy by an asterisk and a footnote. But sufficient remains to enable us to form an idea of its value.

Mons. Secretan, accompanied by two gentlemen holding official positions, and others who are described as very able technical men, but are unnamed, went to the factory at Leeds to inspect it, and to make themselves acquainted with the Elmore process and its cost. Some figures were given them (they have not been sent to us), and they were able to satisfy themselves that those figures were perfectly exact.

The statement represented by the asterisk is prepared on the supposition of an output of 900 tons per month—which could be reached in a very short time. The expenses are taken at a maximum—nothing on earth can make them heavier, whilst it is only necessary to prepare a definite project and they are at once reducible. The statement was not so thorough as it might have been, since some articles sold at high prices but cheaply made are omitted from it, and have to be specially mentioned in the report. No hint is given as to the nature of these articles. They may be *articles de vertu*, or they may be *articles de cuisine*. In his pre-Elmore days Mons. Secretan was famous both for his art collection and his hospitality, so both may have been

in his mind. Mons. Secretan has rapidly acquired the true Elmore manner for, having made a series of statements, they become “well established,” and work must be commenced forthwith. The statement having been prepared on a basis of 900 tons, Mons. Secretan concludes that the directors may find it more prudent to arrange for an output of 300 tons. We are tempted to ask whether a profit does not, to some extent depend upon the extent of output, and whether the brilliant result doubtless foreshadowed in the statement is equally applicable to an output of exactly one third? The report concludes with the remark that manufacture being once decided upon, one can, without rashness, predict a brilliant future for the company, and instances itself (the report) in another characteristic Elmore touch as a justification of the heading of the prospectus “a revolution,” &c.

This is the report which Mr. Stepney Rawson sends us in confirmation of his statement that competent authorities have verified the correctness of the statements made as to the cost and quality of the articles manufactured. This is the report to act upon which the Directors pledged the whole substance of the company for a loan of £50,000.

Had Mr. Rawson permitted the statements to have remained without this confirmation, the statements would have been more generally credited. Had the directors not acted upon the recommendations of such a document they would have had so much the less to answer for.

So long as the Elmore Company have an undoubted right to withhold information, and exercise it, they must expect people to form impressions upon the material open to them. In businesses conducted in a business-like way, enquiries as to cost of manufacture are seldom indulged in and less seldom conceded. The Elmore business is not conducted in such a manner. From first to last the proceedings have been such as to give but one impression, which we will express in plain English as absolute distrust.

We are concerned for the possible waste of money, as we have said before. The borrowed £50,000 and the balance remaining to the company after payment of the purchase money, are not yet spent. Are there none of the directors who can see the wisdom of waiting until the English factory pays its way before starting a French one? Is there not one shareholder sensible enough to realise that loss of time is better than loss of money, and protest accordingly?

The directors should remember that they will not always have an undoubted right to withhold information from everybody. A time will come when they will have to render an account of their stewardship. When the time does come, if the account be unsatisfactory, stock phrases at the shareholders' meetings will not avail them much. They cannot say that the possibilities of adverse results have not been put fully and fairly before them.

Notwithstanding the risk we run of having some indignant shareholder complain of the number of our columns devoted to the subject, there are two other phases of the Elmore question which we should like

to touch upon. Mr. William Elmore has written to the newspapers to explain that the fall in the price of the shares is due to the recent financial crisis, and the realisations of weak holders. Mr. Elmore will find a more reasonable explanation in our columns. On October 3rd, we wrote that the public should clearly understand that the price of Elmore shares is simply a measure of the reliance of the holders on the absorption of more sub-companies. The same remarks apply now. The change in price is the change in the reliance of the holders.

The other phase is the "Trust." Now a trust may be formed for one of two reasons—or a combination of both: to obtain more cash from the public, or to concentrate voting power in the inner circle. The only one of these which concerns us is the first, and we think there is now little risk of its being operative. The public can understand that inasmuch as two blacks do not make a white, neither do four insecurities constitute a security.

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## UNDERGROUND SUBWAYS.

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SOME time ago a Bill was promoted in Parliament to authorise the construction in London of a subway in which all underground pipes, and particularly gas and water mains and electric light cables, should be laid. The Bill, which was not formulated in a judicious manner, was strongly opposed by the gas, water, and electric light companies, and was ultimately thrown out. This result has, however, not discouraged the metropolitan local authorities. The members of the Strand Board of Works are uniting with those of other districts in drawing up a memorial to be presented to the London County Council, asking that a Bill should be introduced in the next session of Parliament to authorise the construction of a subway to contain all underground pipes, and thus prevent the present method of indiscriminate laying adopted by the various companies.

That the time will eventually arrive when some kind of subway, or subways, will be necessary in the metropolis for the accommodation of the various pipes and conduits there can be little doubt, but at present, and probably for some time to come, there does not appear to be any such necessity. If, indeed, the same conditions prevailed here as now obtain in New York, the companies concerned would possibly appreciate an efficient subway or subways, provided, of course, they were not required to contribute towards the cost which, to say the least, would be enormous. The *Engineering News*, of New York, gives in its issue of the 1st inst., a page plan of the pipes, conduits, &c., at the intersection of Broadway and Fulton Streets, New York City, prepared from a survey and drawing made by order of the Commissioner of Public Works. The plan shows what is termed the "Broadway Underground Tangle," or, in other words, a labyrinth of gas and water mains, sewers, Edison conduits, electric subways, electric subway vaults, electric subway air pipes, Com-

mercial Cable Company's conduit and vault, pneumatic tube boxes, Steam Company's conduits, steam expansion joint vaults, return pipes, cellar vaults, together with manholes, gas and water stop-cocks, receiving basins, &c. This medley of pipes and conduits is being aggravated by the continual undergrounding of electric light cables, which were formerly carried overhead in the American "happy-go-lucky" fashion. This system of indiscriminately placing below ground all kinds of pipes has, indeed, not been without effect. Explosions, due to various causes, have been the order of the day, and even now frequently occur, although very little is heard of them—possibly because "use is second nature." These explosions are due to a variety of causes. The escape of steam from the steam pipes has deteriorated—and continues to deteriorate—the insulation of the electric light mains leading to the formation of short circuits, and the escape of gas from the gas mains has then come to the fore, with the inevitable result of a nice little blow up. The dropping of lighted matches down manholes has also contributed its share towards destruction, whilst sewer gas has likewise given its assistance.

Surveys are at present being made of underground Broadway, and the cross sections already taken show gas and water mains, the latter up to 36 inches in diameter, crossing and recrossing the street without any apparent cause, in the case of the gas mains, whilst electric subways and conduits, pneumatic tubes and steam heating pipes interlace with each other, and twist about sewer manholes and over cross town sewers in an utterly lawless and incomprehensible manner. This deplorable state of affairs, in this and other streets in New York City, will, however, probably be changed, and some kind of subways will be built to enclose the various systems of pipes.

Fortunately, with the exception of the Strand, along which probably more traffic is carried daily than on any other thoroughfare in the world, London streets are tolerably free from a confusion of underground pipes. Nevertheless, considerable difficulties have arisen in many other streets, owing to the lack of sufficient space to lay electric light conduits either at a sufficient depth, or in the most convenient spot desired by the companies. The proposed Bill would, if it passed through both Houses, provide for the construction of a subway which would contain all the systems of pipes and conduits—an ideal of perfection, according to the promoters. There are, however, many difficulties in the way of bringing such a scheme to a successful issue. In the first place, the cost of making the subway would entail an enormous expense—probably several millions sterling—and who would pay the piper? The money would hardly be raised on loan by the London County Council, for, if so, the companies interested would, on the completion of the work, be called upon to pay a rental for utilising the subway, and this would amount to a not inconsiderable item in the cost of production, which, correctly defined, is that sum which remains after *all expenses* have been deducted. Provided that the County Council did not raise the money, an attempt might be made to get a clause inserted in the

Bill to compel the gas, water, and electric light companies themselves to construct the subway, since it would be built for their convenience—oh, no—for their use. That such a clause could be passed seems incredible. The companies are already strongly represented in Parliament indirectly, and, with the assistance of other members, it is fair to assume that such an objectionable clause would be rejected.

The proposed subway would during the course of construction not only cause considerable interruption in the supply of water, gas and electric light, thus entailing great loss to the companies, but it would also necessitate the reorganisation of the three systems of distribution, another item of great expense. Again, if a subway is to be made, the question arises as to the kind of subway to be constructed, but this need not be referred to in detail. Suffice it to say, that if a subway is to be built, the gas, water and electric light mains must not be placed therein after the haphazard style adopted in Paris or in New York. The ideal subway appears to be one arranged in divisions, each being distinct from one another, and each being water and air tight. As to the raising of the money, this matter had better be left for the consideration of those long-headed individuals who have plenty of spare time, and scarcely anything to do but inconvenience public companies and spend ratepayers' money.

"Necessity is the mother of invention," and when the time arrives for the construction of a subway, necessity will show itself in the elaboration of a suitable subway. At present, however, there is no such need, and the proposed Bill, if it assumes definite form, will doubtless meet the fate of its predecessor.

regard to the coil. To prove the principle on which incandescent lamps are operated by an induced current, a glass jar of water was placed over the coil; submerged in the water was a coil, to which was attached an incandescent lamp, which burned brilliantly. By simply raising the jar the intensity of the light produced was regulated in a most perfect manner, the lecturer saying there was no longer any truth in the assertion that the electric light could not be raised or lowered. A jar of water being held over the coil, into which was dropped a hollow copper ball, the ball commenced to rotate. Professor Thomson also showed some experiments in electric welding, and a device somewhat similar to a gyroscopic top. The final experiment was extremely interesting. A small motor, consisting of a circular coil, being fixed horizontally with a slot cut through one side, a pivotted disc working in or close to the slot rotated rapidly when the current was turned on. Removing the disc the machine became a counterfeit coin detector, for it possessed this remarkable characteristic that if a genuine silver coin was placed near the slot it would be drawn into the vortex, as it were, and instantly flung out on top of the coil while a counterfeit coin would not be in the least affected.

The American Eagle  
on the Wing,

The *Boston Herald*, of November 5th, contains what is apparently the reproduction of an article written in the *New York Sun* under the somewhat alarming title of "A Source of Danger." Fearful as to what fresh perils awaited unfortunate humanity, we read, and trembled. Imagine then our relief when we found that it was only our old friend electric lighting again to the fore, or let us say, at sea, for the sub-title of the article in question is "Improper Electric Wiring of Ocean Steamers on the English Plan." We are told that the *Etruria*, on a recent passage across the Atlantic, was on two occasions threatened with fire, owing to the imperfect insulation of the electric light wires, and we alluded to this matter in a Note (p. 368), as also did Mr. Rankin Kennedy in our correspondence columns (see REVIEW for October 3rd), in a letter which might be again read with advantage. Horror struck at the thought of the frightful catastrophe which might have attended the fires which nearly occurred, we read on, hoping to find some brilliant suggestion for the prevention of this source of danger. And we found it—an advertisement of Edison plant. But let us give the article full justice. The case of the *Etruria* serves as a *raison d'être* for instituting a comparison between the American and English methods of ship-wiring. Needless to remark, it is not our cousins who suffer in the contrast. We are informed that ship installations on the English plan have not sufficient safety fuses, that the insulation of the wires is imperfect, and that the employment of the hull as a return circuit is not only an inefficient, but absolutely dangerous plan. It will be of interest to English electric lighting engineers to learn that the two-wire, or metallic circuit, is the "American" method. Nor is it of any less advantage to realise that this is the particular system in which the copper wires are carefully insulated with "a material," then drawn through lead pipes, and finally let into a heavy moulding. Let English engineers take heed to this note of warning. It is only a matter of time until the "criminally dangerous system" adopted by them in ship wiring must give way to the "vastly superior" American method; at least, so says the *Sun*.

The Properties of  
Alternating Currents.

THE Boston Electric Club held its first meeting of the season on the 10th inst. Professor Elihu Thomson delivered the inaugural address, choosing for his subject "The Properties of Alternating Currents," and illustrating his lecture with numerous experiments. The Professor said that the alternating current had been experimented on with alternations as high as 8,000 per second. What was really needed was a machine to produce 500 trillions of vibrations per second, from which some wonderful results might be expected. He then described the general properties connected with the alternating current, and to demonstrate his statements he had a powerful coil placed on end on a stand, and secured to a wooden upright, to which he attached first one device and then another, as he required. The coil was excited by an alternating current, a copper ring, about six inches in diameter and three-eighths thick, was held in the air above the top of the coil, and by induction the ring was held in mid air. Another ring then placed below the first, clung to it by magnetic force. The rings either floated or jumped about according to the angle the rings made with the coil. A copper hollow ball, placed on a plate just above the coil, began to rotate, but was speedily stopped by introducing a sheet of copper between the plate and the head of the energised coil. A pivotted copper disc revolved rapidly when brought near the coil, its direction in running depending on its position in

## Subway Explosions.

THE repeated and alarming explosions which have occurred in the street junction boxes of the Newcastle Electric Supply Company, which, besides causing considerable derangement of the flagging, have occasioned slight injury to several persons, have been attributed to leakage of gas; but as the explosions have taken place during or after rain, and the boxes are by no means wet proof, it is at least open to doubt whether the true explanation is not the formation of hydrogen owing to the 2,000 volt alternating current leaking between the bare uninsulated connectors that are employed for joining the mains, through water in the boxes, which hydrogen, being mixed with air previously in the box, is fired by a spark, resulting on the level of the water becoming depressed, and the contact being thereby broken. In any case, that explosions can be originated in this manner is capable of experimental proof. It is only fair to the other electric lighting company in Newcastle—the Newcastle and District Electric Lighting Company—who have now an equivalent of 7,000 10-C.P. lamps coupled to their mains, to mention that no accident of this kind has occurred in connection with their service since starting in January last. This company's junction boxes being of cast iron, with screw-down lids, are quite water-tight, and the joints in the cables being all insulated with India-rubber vulcanised *in situ*, it is difficult to imagine how in their case any explosion could by any possibility take place.

## The Electric Light on Ship-Board.

THE Institute of London Underwriters, stimulated by the appeal of Mr. Leonard Wakefield, of Lloyd's, is endeavouring to have the system of electric lighting at sea set at once upon a more satisfactory footing. Lloyd's Register of British and Foreign Shipping, better known as "The Book Committee," were requested to indicate in their Register every instance in which a vessel is lighted by electricity, and to bring electrical installations under their rules of survey, and the engineer surveyors of the Book have drawn up and submitted a practical report, concluding with a scheme of regulations for adoption by the committee. The dangers involved by the use of the electric light on board ship are, says the report, of two kinds. First, the dynamos themselves, and the electric currents in the cables, have an influence on the ship's compasses; and, next, there is the more obvious danger of fire. In order to minimise the first risk, it is recommended that dynamos and electric motors be placed as far as possible from the compasses. Where the single-wire system is used, and the ship itself is made a medium for the return current, the compass is in danger of being deflected. By resorting to the double-wire system, the return current can be so carried past the compass in the reverse direction as to counteract the influence of the main wire. This system, therefore, is encouraged by the engineers. Where, however, the single-wire plan is, notwithstanding, followed, then the committee are advised that the distance between the wire and the compass should in no case be less than 15 feet. It is recommended that special precaution be taken to test the compasses whilst the dynamos are working at their full capacity, and the same tests be applied whilst the groups of lights are switched in and out. With respect to the fire risks, they are more mul-

tiferous. Great care should be taken to secure a perfect insulation of the wires, not merely of a high initial resistance, but one which will be permanent. The conditions of non-conductivity on shore and at sea are different things. An insulation, which may be permanent enough on dry land, may fail to hold out against conditions maritime—against the changes of temperature, the moisture of the salt water incidental to transit at sea. The recommendations of the report as regards the effective insulation of wires and cables are of great value, and the electricians have further called attention to the fact that methods of protection which may be good enough in some parts of the ship may require supplementing in parts where the risks arising from rough usage or heat are more considerable. Special advice is given as to the safeguarding of joints and junctions against the effects of moisture. To safety fuses, also, close attention is recommended. But the "cut-out" is no protection against the consequences of thinning of the wire by corrosion, or against a break caused, for example, by a too taut setting of the wire. These dangers can only be prevented by careful attention to the work throughout. In petroleum vessels, a special danger has to be provided against; for, an incident of the carriage of petroleum is the accumulation in certain localities of an inflammable vapour, which, it is believed, is liable to be ignited by the electric spark. On vessels which had been recently discharged of their petroleum, heavy accumulations of explosive vapour are especially to be feared. The switches on oil-carrying vessels should, it is urged, always be placed above the upper deck, in the open air, or in places removed from possible gaseous accumulations; and other suggestions are made by the electricians to similar purport.

## The Telephone in Competition.

FOR the past eleven years a highly successful telephone exchange, conducted by a local company, has been in existence in Sheffield, and during the latter portion of that time the National Telephone Company has also had an exchange in the same town. As the expiration of telephone patents approaches, the competition between these companies grows more keen, and the rates that are now being charged in Sheffield may, in all probability, be taken as an indication of the rates that will obtain in all other large towns, in the immediate future. The local company recently announced a reduction of rates to £7 per annum, and this was at once followed by a reduction on the part of the National Company to £5 per annum. In view of the arrangements that are rapidly being made to challenge the monopoly of the National Telephone Company in all large centres, by properly constituted companies, it remains to be seen how soon the National Company will still further realise the nature of the coming struggle, and how soon it will meet the same by a general reduction of rates to the level to which it has shown the way in Sheffield. Meanwhile the Sheffield Company is preparing to join hands with the new companies for mutual support, and if inter-town communication is to be a real necessity of future telephonic developments, it may reasonably be anticipated that through wires for the same will readily be provided by the Postmaster-General, and probably on terms that will be less burdensome than those that have been self-imposed by the National Telephone Company.

## ON THE ACTION OF LIGHTNING DURING THE THUNDERSTORMS OF JUNE 6th AND 7th, 1889, AT CRANLEIGH, SURREY.\*

By CAPT. J. P. MACLEAR, R.N., F.R.Met.Soc., F.R.G.S.

DURING the thunderstorms of June 6th and 7th, 1889, so many trees were struck within a radius of 4 miles from Cranleigh, that I set to work to discover, if possible, the cause of selection of these particular trees; for, contrary to general expectation, they were not the highest nor the most prominent in their immediate vicinity; and though I cannot say I have solved the question, as the causes of preference appear to be very slight, yet I think I can put forward some interesting facts which may help us to a further knowledge of the nature of the electric discharge, and the course it may be likely to follow.

On June 6th, the storm first appeared to the southward of Cranleigh, about 4.43 p.m., and it passed about 4 miles to the south-west. About 5.30 p.m., shortly before rain commenced, the following objects were struck, apparently about the same time, but as no accurate observations were made as to time, it cannot be determined whether one or several discharges were concerned. On Dunsfold Common, 4 miles south-west of Cranleigh, a cottage was struck, a chimney at the south-east end knocked down, and the register grates on two floors started from their places; a haystack about 100 yards south of the cottage was set on fire, and two poplars 300 yards west of the cottage were struck, each tree having a score down it,  $1\frac{1}{2}$  inches width of bark being stripped off. On Hascombe Hill,  $1\frac{1}{2}$  miles north of the cottage, and 400 feet above its level, a spruce fir was shivered; at Alford,  $1\frac{3}{4}$  miles south-east of the cottage, two oaks were struck, one was only scored, but the other was split (this latter tree was struck again and splintered the next day); also three oaks about a mile to the westward of the cottage were struck, but as it is only conjecture that they were struck at the same time, I shall not refer to them again. More trees may have been struck in the neighbourhood, but not noticed.

As for the causes of these objects being selected, it will be seen that they lie nearly in a line north-west and south-east, 3 miles in length. Mr. Marriott has shown (*Quarterly Journal*, No. XV., p. 222) that the storm was passing in a north-west direction with a south-east wind; it is possible that the storm was delayed by the high Hascombe hills, and the charged cloud thereby concentrated. The spruce fir was very prominent on the southern brow of the hill; it divided into two arms nearly in line with the stem; one arm was thrown to the ground, the other blown down by the wind a few hours afterwards. At the junction of the arms there was a great deal of turpentine, which was thoroughly blackened. In this case I should consider that the prominence of the tree made it the best communication to earth, and that the collection of turpentine at the juncture of the arms was raised to explosive temperature, and split the tree.

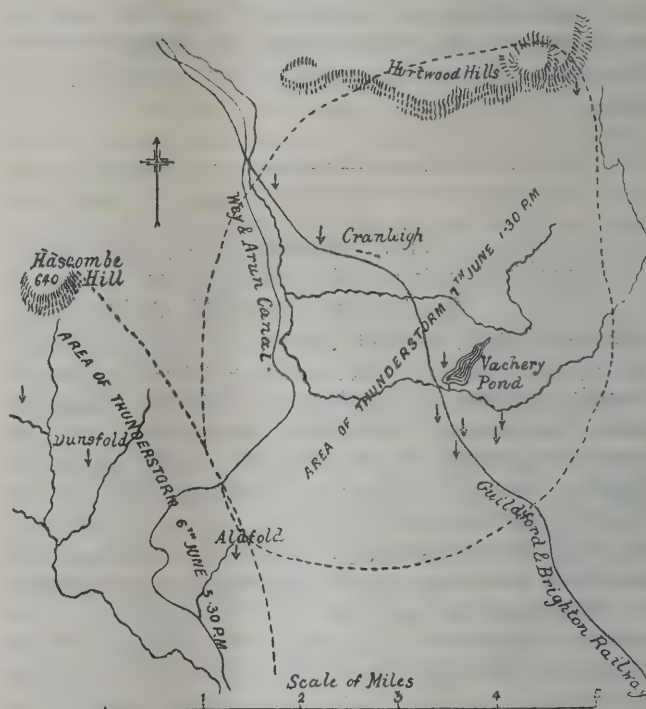
The cottage, haystack and two poplars on Dunsfold Common do not immediately suggest a cause of selection, but from their position the ground falls to the south-east in a wooded valley through which the Arun and Wey canal runs, and on the other side of this wooded valley are the Alford trees. Streams into the canal run from near all the objects struck, and though I hesitate to advance this point, it is possible that the earth electricity was thus able to collect more readily at these places than at others under the cloud. It would be exceedingly interesting to know if these objects were all struck by the same discharge.

On June 7th, the storm began with little warning at 1.10 p.m., and was at its height at 1.27, when there fell the heaviest rain known to the oldest inhabitant. About 1.30 p.m. the following objects were struck:—Near Vachery pond, a large reservoir for the Arun and

Wey canal,  $1\frac{1}{4}$  mile south-east of Cranleigh, six oaks a chestnut, and an ash, in various positions within  $\frac{1}{2}$  mile of the pond and about  $\frac{1}{4}$  of a mile apart, a young fir and three young oaks in the middle of a copse on the slope of the ground near the pond, four oaks  $\frac{1}{2}$  a mile south of Cranleigh, one oak on Cranleigh Common, a chimney and stable 1 mile north-west of Cranleigh, besides the oak tree before mentioned at Alford, and a single oak occupying a fairly prominent position on the slope of the high hills  $2\frac{1}{2}$  miles to the north-east of Cranleigh. This last tree was struck just before the rain commenced on the hill, and was split; the other trees struck, during the rain, were only scored.

Here the area of discharge extends along a line about three miles in length north-west and south-east, as on the previous day; and with the exception of the Alford tree before referred to 3 miles to the south-west, and the tree on the hill 3 miles north-east, all the objects struck were scattered along the line of railway, and at no great distance from it.

It is not easy to see the cause of selection, for these trees were not the most prominent nor were they on the highest ground in the vicinity; the only feature the groups possessed in common being that they were all either near ditches which were full of running water, or else near temporary courses taken by the deluge of water from the higher to the lower ground. The most puzzling case is that of the young fir tree and three young oaks in the middle of the copse near



Vachery pond; they were not higher than the other trees in the copse, but there certainly was a temporary water course running close to them; other trees, however, stood equally close to the water, and unless a large squirrel's nest of moss on the top of the young fir be called upon to account for the selection, it still remains obscure. Another curious case is that of the stable struck, which was overshadowed by tall elms, where it might have been supposed that these would have taken the stroke.

Of the species of trees struck, the oak is the most frequent, and I am inclined to believe that the reason is not that there are more oaks than other trees in the neighbourhood, but that the roughness of the bark causes gaps of its continuity as a conductor; elms, firs, poplars and chestnuts have been struck, but it is said that the beech is never struck.\* It has been said, also, that oaks are more frequently struck in the spring and other trees in the autumn, but this requires confirmation.

\* Read before the Royal Meteorological Society.

\* "The Action of Lightning." By Colonel Parnell.

The injuries to the trees are of two kinds: the first, by far the most common, is simply a score out of the bark up the trunk of the tree, out along one limb, and then by perhaps two or three branches to the outer twigs; in some cases portions of the bark are blown off as well. A very good illustration of this effect is found in a paper by the Rev. O. P. Cambridge, "On the Effect of a Flash of Lightning at Bloxworth," April 9th, 1886.\* In these cases I imagine that the rain is falling, and one or more streams of water are running down the sides of the tree, forming a conductor which becomes insufficient, at the time of discharge, to carry off all the electricity, and therefore becomes so suddenly converted into steam as to blow out the bark along the line, and if there is communication with the sap by a knot, hole, or other flaw, the sap is also converted into steam and the bark blown off.

The other form is the shattering of the tree, which I imagine to occur when the electricity is insufficiently carried off by the outer surface, and collects at the junction of some main branch with either the stem or with some other branch, where there is perhaps a cavity of water in it, or a collection of moist dead leaves; the tree is then easily rent by the explosion of steam generated. If the tension be very great, and especially if the air round the tree be dry, the sap may be violently exploded, and trunk splintered and shattered as if by dynamite.

Of the trees which I have examined here, the only ones shattered were those struck before the rain fell; the others were scored simply, with bark blown off.

In the case of the stable struck on June 7th, I can only think that the electricity collecting at the top of the overhanging elm tree found a better conductor than the trunk in the hot moist air escaping from the near gable of the stable, and the hot air expanding blew the corner tile off to find a better vent. As to the cottage on Dunsfold Common, struck on June 6th, I can trace no cause for selection; the appearance of the chimneys suggests an explosion of air.

As the result of my examinations I can only say that the causes of selection of objects struck appear too slight to be readily perceptible, or to enable one to say beforehand that such and such an object will probably be struck. It seems that during rain every tree is conducting electricity, and a disruptive discharge takes place where the conductor becomes insufficient. This would depend on the position of the cloud, the amount of foliage on the tree, its condition of moisture, and its connection with running water. Also I may point out, as shown by Prof. O. J. Lodge, that if an upper cloud should discharge to a lower one, the lower one may then discharge to earth violently without regard to any conductors.

It would be desirable if those who have the opportunity of observing objects immediately after they are struck would note the surrounding conditions and proximity to water, and whether, in the case of trees struck during rain, the score is on the side on which the rain beats.

### THE HAZELTINE ARC LAMP CARBON SHIELD.

MANY of our readers readily recall the time when arc light carbons were sold at the rate of \$1 a dozen and were not even then considered excessive in price. Since those pioneer days, says the New York *Electrical Engineer*, there has been a continual diminution in the price of carbons, but with the enormous increase in the number of arc lamps burning nightly, the total expenditure involved amounts to many hundreds of thousands of dollars annually. It has, therefore, been the aim of many to increase as much as possible the life of the carbon on the one hand, or to increase its illuminating power with the same expenditure of electrical energy. These attempts have resulted in the

application of various devices, either mechanical or as ingredients of the carbon itself, but, so far as we are aware, scarcely one of these methods has come into practical use, the pure carbon of to-day being still universally employed. The advent of a simple device by which an actual economy in the operation of the arc lamp is effected will, therefore, be of considerable interest, and for that reason we desire to call the attention of our readers to a simple and effective device of the kind due to Mr. W. B. Hazeltine, Jun., of the Hazeltine Electric Company, of St. Louis. This device, which is illustrated in the accompanying engravings, figs. 1 and 2, consists simply of a sleeve of refractory material, forming a protective shield, or tip, which is freely suspended so as to hang in close proximity to the tip and the upper carbon close to the arc, the suspension device being so arranged that the sleeve is automatically maintained at its proper position near the arc. The effect of this simple arrangement, as has been shown by actual experience, is that the life of the carbon is practically doubled, so that an ordinary eight-hour carbon is able to burn 16 hours without retrimming. The exact action to which the saving in carbon and increase in

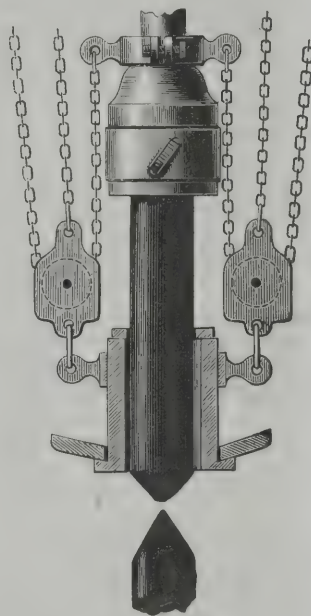


FIG. 1.

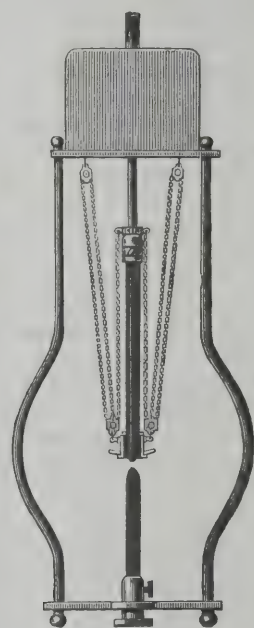


FIG. 2.

life is due has not yet been fully analysed, the fact remaining, however, as described. The shape of the carbon when protected by the shield is modified somewhat from that usually noted. The economical advantages gained by this device must be apparent. In the first place, not only may a large saving be effected in the carbon bills, but another important item, the cost of trimming lamps, may be reduced in almost the same ratio. A further attribute of the shield consists in the fact that it acts as an automatic cut-out whenever one or the other of the carbons is consumed, thereby preventing the destruction of the carbon holder, it being impossible, of course, for the holders to approach nearer to each other than the length of the shield. Aside from the economy in carbons and trimmer's services, it is pointed out that the convenience to customers of having their lamps trimmed every other day, instead of every day, as at present, will no doubt have the effect of increasing the popularity of the arc lamp. Besides, the consumption of the carbon is so complete that very little carbon dust settles at the bottom of the lamp, so that cleaning may also be deferred to the same time as trimming. We may add that the Hazeltine shield has been tested by Mr. James I. Ayer, superintendent of the Municipal Electric Light and Power Company, St. Louis, operating 3,000 lights, who, after a careful trial, fully corroborates the inventor's claims, which are also attested by the Western Electric Company, in whose factory a similar test was recently made under the supervision of Mr. C. A. Brown.

\* This paper is in the Library of the Royal Meteorological Society.

## THE LINEFF SYSTEM SCORES.

"HURRAH! at last the battle is over and we are victorious. The fighting was severe, but, thank God! we have won the day." These words, which were once uttered by an old English soldier, are peculiarly applicable to the position of the West Metropolitan Tramway Company in relation to the Hammersmith Vestry. It is the old, old story of the opposition of local authorities to electric lighting and traction, and when the local "powers that be" object in such cases, it requires a high *voltage* to induce the Board of Trade to overrule their objections. So much is this the case, that the latter Department almost invariably supports the Vestries, Local Boards, municipalities, &c., which constitute local authorities.

When in an 1887 Session of Parliament the West Metropolitan Tramway Company obtained a special Act authorising the employment of electric traction on the company's lines—about  $8\frac{1}{4}$  miles long—it was thought that electric street traction would assume a definite form in the metropolis. The tramway company and others interested were, however, doomed to disappointment. The local authorities, and particularly the Hammersmith Vestry, now locally notorious as having spent over £1,000 of the ratepayers' money in opposing the granting of the above-mentioned Act, flatly declined to give permission for the use of the Lineff open conduit system which the tramway company had originally intended to lay down. The latter were wise in their generation. The Act did not authorise them to break open the roadways, and as the local authorities were obstinate, the company did not care to experiment with the vagaries of storage battery cars. "Wise men of the west" were, indeed, the directors of the tramway company.

A year passed away, and in that quiet corner of the Chiswick dépôt of the tramway company experiments were commenced with a new system of electric traction. These were conducted for some time, until the Lineff closed conduit system became experimentally an accomplished fact. Before the first public demonstration of the system was given, the line was shown in operation to the local authorities.

It was then thought that, as the new system overcame the objections raised against the open conduit method, the local authorities would readily consent to its adoption on the Hammersmith-Kew line, or on that from Young's Corner to Uxbridge Road. Unfortunately, this expectation was not realised.

The Brentford and Chiswick Local Boards gave their permission, but the third local authority concerned—the Hammersmith Vestry—again refused to do so. The tramway company were thus placed in an awkward position. It was either necessary to again apply to Parliament to authorise the breaking up of the roads, or, Micawber-like, to wait "for something to turn up." Pressure—high pressure, of course—was, however, brought to bear upon the vestry, who a few weeks ago resolved to grant permission for the laying down of the magnetic conductor, subject to a favourable report being received from an expert whom they appointed. Favourable reports were received by the vestry from Mr. W. H. Preece, Mr. G. Kapp, and Prof. Robinson, and on the 20th inst. the vestry unanimously agreed to the proposal of the tramway company to work the line from the Uxbridge Road Station to Kew, a distance of three miles, by the Lineff closed conduit system. The work of laying down the magnetic conductor is to be commenced at once. Thus terminates one of the most obstinate battles which have taken place between local authorities and the promoters of electric traction.

It might appear from the foregoing that the blame has been entirely on the part of the Hammersmith Vestry; but it is believed, and has been stated, that the vestry was perfectly justified in opposing for so long the adoption of the Lineff system. Whatever the reasons for this may be, it is satisfactory to find that after a struggle extending over a period of nearly three years, a definite decision has been reached. It only

remains to be seen whether, when the system has been laid down, the anticipations of the promoters will be realised. We trust that this will be the case, as it will be the first underground closed conduit system to be shown on a practical working scale.

## COMMUNICATIONS FROM AUSTRIA-HUNGARY.

[FROM A CORRESPONDENT.]

THE Popp Compressed Air Company are making everywhere great efforts to obtain a footing for their system in Austria-Hungary. Last week M. Victor Popp made his appearance in person at Budapest in order to carry on a propaganda for his system in influential quarters and to take steps for obtaining the long-coveted concession for erecting and working a compressed-air central station at Budapest. Unless, however, the indications are untrustworthy, the efforts of the Popp Company will not prove successful at Budapest.

In Vienna the Lower Austrian Trades' Association was concerned last week with the Popp system. 249 Viennese firms, tradesmen and industrialists, have handed in to the council of management of the above association a memorial in which they urge that 1,400 Viennese industrialists have subscribed to the "International Compressed Air and Electric Company" for a total of 17,000 H.P., but that the application for a concession has been under consideration for more than 18 months in the Viennese Municipal Council, therefore the association is besought to take steps for the acceleration of their affairs. The council of management has introduced this memorial to the Municipal Council. The president of the association has personally handed the memorial to the presidency of the Municipal Council, and applied also to the director of the magistracy. From both sides the assurance has been given that now the great question of the union of the city of Vienna with the suburbs, no longer claims all the attention of the council, the affair will be quickly taken in hand and brought to a conclusion. But with what result the future must show.

On the 13th of this month the Vienna central station of the International Electrical Company was set in work with the secondary installations connected. The next day other points were experimentally connected, and as the trials on both evenings gave satisfactory results, the regular working will begin to-day, at first with a capacity of 2,000 H.P., with successive extensions up to 10,000 H.P.

Herewith the total cable net of the company which at present branches out for the length of about 33 kilometres and is laid down in various wards of the city will be set in action. The Imperial Palace will be among the objects illuminated.

At the central station of the Brush Company at Temesvar there occurred on the 14th inst., a very deplorable misfortune. About 5.30 p.m., just as the machines for lighting the streets (Brush continuous current dynamos) were set in action the main driving band got in irregular vibration. The attendant on the dynamos and the foreman rushed up with spreading rods to prevent the band from slipping when a whitesmith, who had been employed in the installation for about four weeks, a man of 24 years of age, named Franz Schneider, ran to the dynamo to disconnect the brushes. Schneider was not authorised to do this, but wished, doubtless to show his willingness, to his own misfortune. Instead of laying hold of the caoutchouc handle he seized the brushes with both hands. The entire current of 2,000 volts passed through his body. He was dead in a moment and had to be dragged away by violence. This misfortune occasioned an irregularity in the lighting. The director Clements instantly sent for physicians, but all attempts to restore animation were fruitless.

According to a report of the Hungarian Ministry of Trade, there were in Hungary in the year 1889.

altogether 10 municipal central telephone stations in work with the following result :—

Name of Town.	Subscription monthly.	Number of Subscribers.		
		1887.	1888.	1889.
Budapest ... ..	12½ florins*	933	1,081	1,193
Szegedin ... ..	9 „ **	62	69	56
Arad ... ..	9 „ **	20	17	23
Temesvár ... ..	8 „ **	88	87	86
Pressburg ... ..	7 „ ***	68	76	77
Füsfkirchen ... ..	9 „ **	54	57	48
Agram ... ..	7 „ *	72	68	89
Grosswardein ... ..	7 „ *	...	68	88
Debrezin ... ..	6 „ *	...	65	78
Miskdeez ... ..	8 „ *	...	...	28

\* Without regard to distance.

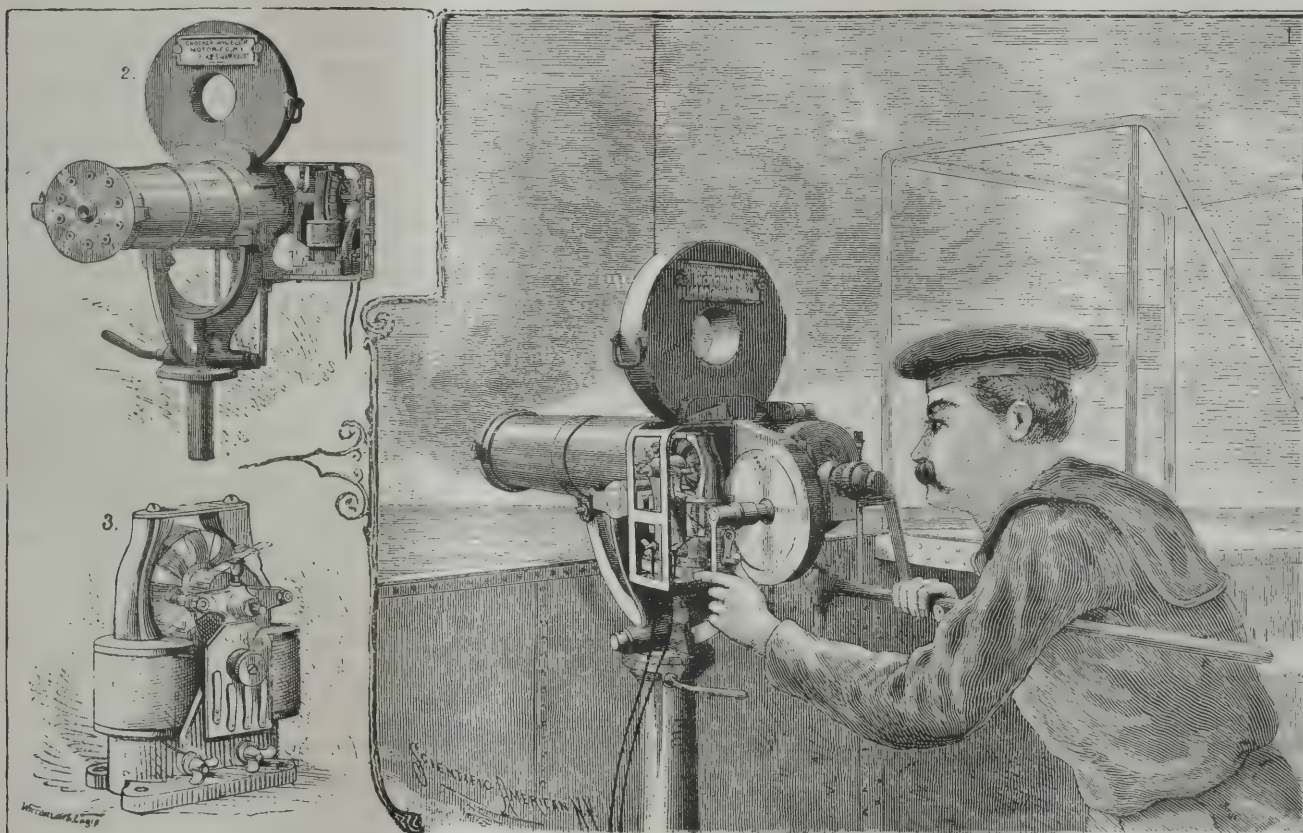
\*\* Up to 2 kilometres distance; another florin for each additional kilometre.

\*\*\* Up to 1 kilometre.

adds a second disturbing element to the vibration due to the recoil.

The Crocker-Wheeler Motor Company, of this city, were invited by the the United States Navy Department to arrange an electric firing mechanism for the Gatling gun. Several requirements had to be kept in mind in producing the design. The apparatus had to be attached to the barrel of the gun, so as to move with it. It had to be out of the sighting line, and it was necessary to dispose of it so as not to interfere with elevation or depression of the gun. The motor finally had to be adapted for operation by the electric lighting plants as installed upon the ships of war. The drawings show clearly how the problem has been attacked.

Upon the left hand side of the breech of the gun an open frame of generally rectangular outline is secured. Within it is placed the motor. This is a specially-wound motor, adapted for an electromotive force of 80 volts, and a current of 3 to 3½ ampères intensity. This, it will be seen, represents the absorption of a



1 The gun in operation. 2 The gun and electrical attachment. 3 The Crocker-Wheeler motor.

#### FIRING GATLING GUNS BY ELECTRICITY.

#### ELECTRICALLY-FIRED GATLING GUN.

THE above illustration from the *Scientific American*, shows a new application of the electric motor, in which it is caused to operate a Gatling gun. This well-known type of mitrailleuse has been placed on many of the United States naval vessels, and represents a very powerful weapon for repelling attacks and for general fighting work at close quarters.

Hitherto the Gatling gun has not been automatic. The loading is effected by turning a crank attached to the breech mechanism of the piece. As this causes the barrels to rotate, they are discharged one at a time. Ten barrels are comprised in the piece, so that for each revolution 10 shots are delivered. While one man turns the crank, a second man, holding the tail stock or lever, may be employed in directing and aiming the piece, if continual change of direction is needed. While this character of manipulation is often required, and is that by which rapid-firing guns should perform the greatest execution, it has attendant difficulties. The turning of the crank inevitably causes the piece to oscillate, and

little over one-third electric horse-power. The efficiency of the motor is placed at over 80 per cent. The spindle of the armature, which in general terms runs horizontally and at right angles to the axis of the gun, carries a pinion which engages a large gear wheel. The latter is enclosed in the cylindrical or disk-like case, which is seen next to the motor by the side of the breech. The spindle of the large gear wheel is prolonged across the end of the gun barrel, and carries a worm at its end. This gears into a worm wheel on the working spindle of the gun.

This double reduction of speed causes the operation of the gun at about 150 revolutions per minute, giving 1,500 discharges. This rate is rather high for general practice, and can be considerably reduced.

A small switch is provided for turning the current on and off. The artillerist, after starting the motor, is free to swing the piece in any direction. This he can do without interference from a second operator, and the gun is undisturbed by the shaking due to the turning of the crank.

Between the motor and the large gear wheel is a clutch, by which the motor can be connected or disconnected from the breech mechanism. The crank by

which the piece is worked by hand under the former conditions, is arranged for rapid disconnection or re-connection. This provides for injury to the electric apparatus. If the latter becomes disabled, or if its connections are severed, the clutch can be thrown open and the handle connected, when the gun will be ready for operation by hand. This change takes only a few seconds. This application of electricity is of special interest, as bringing the Gatling gun into the rank of automatically fired artillery.

### POSTAL TELEGRAPH CLERKS AND THE "QUIN TESTIMONIAL."

A CELEBRATION somewhat on the lines of the now familiar Postal Jubilee ceremonial has to be noticed during the past week, when the Postmaster-General, in what a contemporary terms the "happiest of veins," contributed a not uninteresting speech on the subject of the wonderful spread of postal and telegraphic business in Great Britain during the last 20 years.

The laying of the memorial stone of the vast building in Aldersgate Street, henceforth to be known as the General Post Office North, and which will, it is expected, be finished in 1893, brought together a crowd of officially sympathetic and officially enthusiastic supporters of the Postmaster-General.

Doubtless much complacency distinguished the bearing of those fortunate individuals present who were referred to as the recipients of honours conferred on them by Her Most Gracious Majesty the Queen, and in the eyes of those whom curiosity, if no stronger motive, had attracted to the spot, they would be regarded possibly with feelings not unmingled with awe.

With regard to the matter of honours, while such things as C.B.'s, K.C.B.'s, and G.C.B.'s remain symbolical of the expressions of a sovereign's, and perhaps a nation's favour, it may be well to remind those who in civil capacities have been fortunate enough to secure a place in the struggle for social distinction that much of that distinction, especially in the Civil Service, is due to the ever-increasing labour and responsibility thrust upon those who have to battle for a bare existence, many degrees lower down in the social scale. Military and naval men, as a rule, do not forget that their "ribbon, stars, and a' that," are in a great measure the recognition of the concentrated efforts of phalanxes of their fellow-countrymen, and this is equally applicable to the numerous army of civil servants.

In this direction few probably of the complacent and successful hearers of the Postmaster-General's speech troubled themselves, and no thoughts of the discreditable labour turmoils of the postal administration, which will render the year 1890 famous, were visible on their smiling countenances.

Interested as scientific men are generally in the progress of telegraphy and its practical application to commerce, the amazing progress of the Postal Telegraph Service, and the ever-increasing assimilation of its advantages to the general interests of the community at large, may well occasion them surprise. It seems tolerably certain that the Telegraph Service, given fair opportunities, will outstrip the sister services; the statistics quoted by the Postmaster-General, indicating a greater percentage of increase of public patronage than is shown by the other services referred to by him.

The growth of the Central Telegraph Department alone since 1870 is, indeed, a revelation, and it has been asked, and not without reason, why the able and invaluable labours of the veteran chief, or Controller, have not received decorative recognition. Perhaps this honour is withheld through the agitation which exists in the Telegraph Service, and the failure to raise three spontaneous Jubilee cheers on a recent occasion.

While the memorial stone display was taking place in the chaotic wilds of the General Post Office North, a display of another nature was being made in the

windows of a well-known City photographer, not 100 yards from the General Post Office, and the peculiar character of the latter display formed the subject of articles in several of the evening papers.

Readers of this journal, who have seen articles on the agitation in the Postal Telegraph Service in these columns, may remember the case of a telegraph clerk named Quin, who was dismissed for "talking on the wire," a breach of minor rules, no doubt, but hardly one necessitating such severe and unprecedented punishment. The unanimous feeling amongst telegraph clerks appears to be that Quin—an executive committee man, and appointed to that position almost against his will by the staff at the Central Telegraph Department—was made a martyr, and no doubt, in their opinion, an altogether unnecessary edition of the Israelitish scapegoat, which had to bear the responsibility of a nation's iniquity. As has already been said in these columns, of admittedly irreproachable official character—as well as socially unblemished in that respect, for there is a double distinction here—intelligent, honourable, and honest, Quin's efforts, which largely helped to improve the already comfortable affluence of those who afterwards sat in judgment on him, as well as helping to secure concessions to the staff, only brought to himself censure and dismissal.

It can easily be understood that popular feeling quickly determined that Quin should not go into the world to start life afresh and empty-handed. Though it has been said that "the herd of mankind can hardly be said to think," and that "their notions are almost all adoptive," such does not appear to have been the case in the matter under notice. Subscription lists were quietly but expeditiously sent round the Central Telegraph Department, and a most praiseworthy and generous unanimity resulted in the raising of the magnificent sum of £350 in a very short time. The matter was also taken up in the provinces, with the result that £150 were realised with gratifying alacrity. Nothing approaching this sum has ever been subscribed before, though charity, philanthropy and generosity are by no means strangers to the Telegraph Service, but then on the other hand there has never been a case in which individual and collective responsibility has been involved to so great an extent. The presentation of this handsome sum was to have taken place in public. Notice was given to the "authorities," who gave unmistakable proof that their peculiar code of honour would be outraged by what many in a thoroughly dispassionate neutrality of mind would consider an enthusiasm of noble kindness and gratitude. Equally impartial people will wonder where the right has been acquired which permits of interference with, and practical subversion of, one of our most cherished social institutions—the right of public meeting for the purpose of presenting a testimonial, or the discharge of any other social ceremonial. Possibly the St. Martin's-le-Grand officials may have acquired such rights by methods satisfactory to themselves, but it may be doubted whether they would meet with the approval of the public at large. There being no desire, we suppose, on the part of the Telegraph Clerks to bring about a display of hostility to the Postmaster-General or the permanent officials the projected meeting was abandoned, and the Quin testimonial—which took the form of a tastefully illuminated and kindly worded address, a silver medal, specially struck, and a sum of nearly £500—was presented to the recipient privately.

Into the feelings which must have thrilled the heart of Quin, it is not necessary to enter at any length. The substantial sympathy of his former colleagues will make up something akin to ample recompense for the prospects nipped at the best in the stem only—and it must surely be felt that there were the grandest and most genuine reasons for this extraordinary display of practical and thorough friendship, and that Quin was in every way worthy of the reciprocal loyalty of his friends.

However, happy in the possession of a temperament and a heart not easily daunted, Quin has apparently lost but little time in putting the whole matter before

the eyes of the public in a way which has utterly defeated the desires of those who longed for his relegation to public and commercial obscurity.

The latest phase of the matter will strongly remind some of our readers of the tinker who, in mending one hole, made two fresh ones—in the tinker's case the result was premeditated, but the action of the authorities in the Quin affair has led to the whole thing stepping into the broad light of public opinion, for boldly displayed, in the spacious window of the friendly City photographer's premises may be seen the testimonial from the Postal Telegraph staff of the United Kingdom and the silver presentation medal, together with large and plainly worded cards announcing the circumstances which have led to their exhibition before the eyes of the public.

### RECENT RESEARCHES ON THE ELECTRICAL CONDUCTIVITY OF CERTAIN LIQUIDS.

IN our issue of the ELECTRICAL REVIEW for October 31st, we called attention to some recent researches on the electrical conductivity of certain saline solutions, giving a brief sketch of the work which is being carried on in this direction by some of the French and German scientists. Another German has now entered this interesting field of investigation. Herr F. J. Wershoven has lately been examining the electrical conductivity of aqueous solutions of the cadmium salts. We give a brief *resumé* of his more important results.

Wershoven undertook the study of solutions of the chloride, bromide, iodide, nitrate, and sulphate of cadmium, also of potassium-cadmium oxide; these were examined within wide limits of concentration and temperature.

It was found that the temperature-coefficients of all these salts of cadmium approximated very closely in extremely dilute solutions to 2·3 per cent. per degree. To this statement, however, the iodide and double iodide of cadmium are exceptions.

The variations of electrical conductivity with the variations of temperature may, in the case of concentrated solutions, be expressed by a linear equation for the chloride, iodide, and double iodide of cadmium; an equation of the second degree is, however, required, in order to express these variations in the case of the other salts of cadmium.

Grottrian's figures for electrical conductivity are well known, and have been very generally relied upon, but Wershoven fails to confirm them, and is of opinion that they must not be so implicitly trusted as they have been. He finds that there is sometimes so large a difference as 10 per cent. between his results and Grottrian's numbers, and suggests that possibly the preparations used by the latter were not in a sufficient state of purity.

Wershoven enters into a long discussion of the results with respect to molecular conductivity, the rate of transference of the ions, and the supposed complexity of the salt molecules. This is not capable of useful abstraction for our readers; we therefore merely give the conclusions arrived at.

Arrhenius held that in the case of cadmium nitrate the inactive molecules are not complex, but that in the other salts of this metal they do possess a certain degree of complexity. This view is supported by Wershoven, who finds it to agree with the results deduced from his own experiments.

Combined with the well-known values of Kohlrausch for the speed of migration of the anions (a), chlorine (b), bromine (c), iodine, and (d) the radicle NO<sub>3</sub>, the numbers obtained for extreme states of dilution give the following speeds of the cadmium ion:—

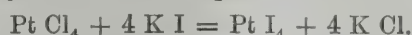
$$\left. \begin{array}{l} \text{For (a) speed} = 49\cdot2 \\ \text{      (b)      } = 50\cdot9 \\ \text{      (c)      } = 49\cdot3 \\ \text{      (d)      } = 53\cdot7 \end{array} \right\} \text{Mean} = 51.$$

The speeds of other ions expressed in the same units are for the following bivalent metals:—

Barium :	speed	...	...	=	51
Zinc :	"	...	...	=	51
Magnesium :	"	...	...	=	53

During the course of his investigation Wershoven found that a freshly platinised platinum electrode, when immersed in a solution of iodide of potassium, had the effect of colouring the solution at first yellow, and then in a few minutes, pink.

This interesting result is not, as might perhaps be reasonably supposed, due to the liberation of iodine, for Wershoven could not obtain the characteristic blue colouration with the usual starch-paste test. He considers that it is accounted for by the formation of platinum tetriodide, which dissolves in the solution of potassium iodide. The reaction seems capable of expression by the following equation:—



In order to obtain this effect it is not necessary to previously immerse the platinum electrode in a solution of platinum chloride; hydrochloric acid alone effects the reaction which indeed may be used as a most delicate test for this acid: it will even give results when the usual reagent nitrate of silver gives no turbidity whatever.

In applying this test, Wershoven recommends the following method of procedure, which we give, thinking it might be of advantage to some of our readers who may be engaged upon certain branches of delicate research.

The freshly platinised electrode is washed in distilled water and then dipped repeatedly into potassium iodide solution until it no longer produces any pink colouration. It is then thoroughly washed with aqueous alcohol, then with distilled water, after which it is placed for some time in the solution which is suspected of containing hydrochloric acid. The electrode is again subjected to careful washing with water and then immersed in a dilute solution of potassium iodide. After a little while the pink colour will appear. Neither ordinary chloride nor hydrobromic or other acid give the colouration, so the test is quite unique.

### THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 633.)

#### SPECIFICATIONS OF ELECTRO-MAGNETS.

One frequently comes across specifications for construction which prescribe that an electro-magnet shall be wound so that its coil shall have a certain resistance. This is an absurdity. Resistance does not help to magnetise the core. A better way of prescribing the winding is to name the ampère-turns and the temperature limit of heating. Another way is to prescribe the number of watts of energy which the magnet is to take. Indeed it would be well if electricians could agree upon some sort of figure of merit by which to compare electro-magnets, which should take into account the magnetic output, *i.e.*, the product of magnetic flux into magnetomotive force—the consumption of energy in watts, the temperature rise, and the like.

#### AMATEUR RULE ABOUT RESISTANCE OF ELECTRO-MAGNET AND BATTERY.

In dealing with this question of winding copper on a magnet core, I cannot desist from referring to that rule which is so often given, which I often wish might disappear from our text books; the rule which tells you in effect that you are to waste 50 per cent. of the energy you employ. I refer to the rule which states that you will get the maximum effect out of an electro-magnet if you so wind it that the resistance is equal to the resistance of the battery you employ; or that if you have a magnet of a given resistance you ought to employ a battery of the same resistance. What is the meaning of this rule? It is a rule which is absolutely meaningless unless in the first case the volume of the coil is prescribed once for all, and you cannot alter it, or unless once for all

\* Cantor Lecture. Delivered before the Society of Arts, February 3rd, 1890.

the number of battery elements that you can have is prescribed. If you have to deal with a fixed number of battery elements, and you have to get out of them the biggest effect in your external circuit, and cannot beg, buy, or borrow, any more cells, it is perfectly true that, for steady currents, you ought to group them so that their internal resistance is equal to the external resistance that they have to work through; and then, as a matter of fact, half the energy of the battery will be wasted, but the output will be a maximum. Now that is a very nice rule indeed for amateurs, because an amateur generally starts with the notion that he does not want to economise in his rate of working; it does not matter whether the battery is working away furiously, heating itself, and wasting a lot of power; all he wants is to have the biggest possible effect for a little time out of the fewest cells. It is purely an amateur's rule, therefore, about equating the resistance inside to the resistance outside. But it is absolutely fallacious to set up any such rule for serious working; and not only fallacious, but absolutely untrue if you are going to deal with currents that are going to be turned off and on quickly. For any apparatus like an electric bell, or rapid telegraph, or induction coil or any of those things where the current is going to vary up and down rapidly, it is a false rule, as we shall see presently. What is the real point of view from which one ought to start? I am often asked questions by, shall I say, amateurs as well as by those who are not amateurs, about prescribing the battery for a given electro-magnet, or prescribing an electro-magnet for a given battery. Again, I am often told of cases of failure in which a very little common sense rightly directed might have made a success. What one ought to think about in every case is not the battery, not the electro-magnet, but *the line*. If you have a line, then you must have a battery and electro-magnet to correspond. If the line is short and thick, a few feet of good copper wire, you should have a short thick battery (a few big cells, or one big cell), and a short thick coil on your electro-magnet. If you have a long thin line, miles of it, say, you want a long thin battery (small cells, and a long row of them) and a long thin coil. That is then our rule; for a short thick line, a short thick battery, and a short thick coil; for a long thin line, a long thin battery; and electro-magnet coils to match. You smile: but it is a really good rule that I am giving you; vastly better than the worn-out amateur rule.

But, after all, my rule does not settle the whole question, because there is something more than the whole resistance of the circuit to be taken into account. Whenever you come to rapidly acting apparatus, you have to think of the fact that the current, while varying, is governed not so much by the resistance as by the inertia of the circuit—its electro-magnetic inertia. As this is a matter which will claim our especial attention hereafter, I will leave battery rules for the present, and proceed with the question of design.

#### FORMS OF ELECTRO-MAGNETS.

This at once leads us to consider the classification of forms of magnets. I do not pretend to have found a complete classification. There is a very singular book written by Mons. Nicklés, in which he classifies under 37 different heads all conceivable kinds of magnets, bidromic, tridromic, monocnemic, multidromic, and I do not know how many more; but the classification is both unmeaning and unmanageable. For my present purpose I will simply pick out those which come under three or four heads, and deal separately with others that do not quite fit under any of the four categories.

**Bar Electro-magnets.**—In the first place there are those which have a straight core, of which there are several specimens on the table here.

**Horseshoe Electro-magnets.**—Then there are the horseshoes, of which some are of one piece bent, and others are of the more frequent shape made of three pieces.

**Iron-clad Electro-magnets.**—Then from the horseshoes I go to those magnets in which the return circuit of the iron comes back outside the coil either from one end or the other, or from both ends, sometimes in the form of an external tube or jacket, sometimes merely with a parallel return yoke, or two parallel return yokes. All such magnets I propose to call—following the fashion that has been adopted for dynamos—iron-clad electromagnets. One of them, the jacketed electromagnet, is shown in fig. 12 and there are others not so well known. There is one used by Mr. Cromwell Varley, in which a straight magnet is placed between a couple of iron caps, which fit over the ends, and virtually bring the poles down close together; the circular rim of one cap being the north pole, and that of the other cap being the south pole, the two rims being close together. That plan of course produces a great tendency to leak across from one rim to the other all round. The advantages, as well as the disadvantages, of the jacketed magnet I alluded to in my last lecture, when I pointed out to you that for all action at a distance it is far better not to have an iron-clad return path, whereas for action in contact the iron-clad magnet was distinctly a very good form. In one form of iron-clad magnet the end of the straight central core is fixed to the middle of a bar of iron, the ends of which are bent up and brought flush with the top of the bobbin, making thus a tripolar magnet, with one pole between the other two. The armature in this form is a bar which lies right across the three poles. There is an example of this excellent kind of electromagnet applied in one of the forms of electric bell indicator made by Messrs. Gent, of Leicester.

Then, besides these three main classes—the straight bar, the horseshoe, and the iron-clad—there is another form which is so useful, and so commonly employed in certain work, that it deserves

to have a name of its own. It is that called by Count Du Moncel the *aimant boîteux*, or club-footed magnet (fig. 50). It is a horseshoe in fact, with a coil upon one pole and no coil upon the other. The advantage of that construction is simply, I suppose, that you will save labour—you will only have to wind the wire on one pole instead of two. Whether that is an improvement in any other sense is a question for experiment to determine; but on which theory perhaps might now be able to say something. Count Du Moncel, who made many experiments on this form of magnet, ascertained that there was for an equal weight of a copper a slight falling off in power with the club-footed magnet. Indeed one might almost predict, for a given weight of copper, if you wound all in one coil only, you will not make as many turns as if you wound it in two; the outer turns on the coil being so much larger than the average turn when wound in two coils. Consequently the number of ampère turns with a given weight of copper would

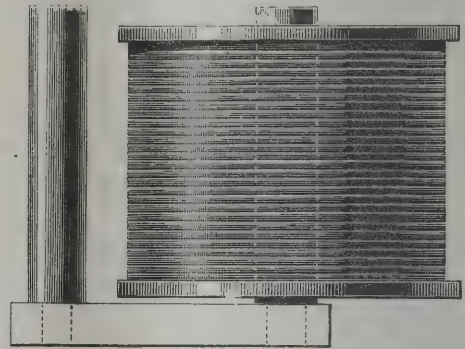


FIG. 50.—CLUB-FOOTED ELECTRO-MAGNET.

be rather smaller, and you would require more current to bring the magnetising power up to the same value as with the two coils. At the same time the one coil may be produced a little more cheaply than the two; and, indeed, such electro-magnets are really quite common, being largely used, for the sake of cheapness and compactness, in indicators of electric bells.

Du Moncel tried various experiments about this form to find whether it acted better when the armature was pivoted over one pole or over the other, and found it worked best when the armature was actually hinged on to that pole which comes up through the coil. He made two experiments, trying coils on one or other limb, the armature being in each case set at an equal distance. In one experiment he found the pull was 35 grammes, with an armature hinged on to the idle pole, and 40 grammes when it was hinged on to the pole which carried the coil.

Another form of electro-magnet, having but one coil, is used in the electric bells of church-bell pattern, of which Mr. H. Jensen is the designer. In Jensen's electro-magnet a straight cylindrical core receives the bobbin for the coil, and after this has been pushed into its place, two ovate pole-pieces are screwed upon its ends, serving thus to bring the magnetic circuit across the ends of the bobbin, and forming a magnetic gap along the side of the bobbin. The armature is a rectangular strip of soft iron, about the same length as the core, and is attracted at one end by one pole-piece, and at the other end by the other.

#### EFFECT OF SIZE OF COILS.

Seeing that the magnetising power which a coil exerts on the magnetic circuit which it surrounds is simply proportional to the ampère turns, it follows that those turns which lie on the outside layers of the coil, though they are further away from the iron core, possess precisely equal magnetising power. This is strictly true for all closed magnetic circuits; but in those open magnetic circuits where leakage occurs it is only true for those coils which encircle the leakage lines also. For example, in a short bar electro-magnet, of the wide turns on the outer layer, those which encircle the middle part of the bar do enclose all the magnetic lines, and are just as operative as the smaller turns that underlie them; whilst those wide turns which encircle the end portions of the bar are not so efficient, as some of the magnetic lines leak back past these coils.

#### EFFECT OF POSITION OF COILS.

Among the other researches which Du Moncel made with respect to electro-magnets, was one on the best position for placing the coil upon the iron core. This is a matter that other experimenters have examined. In Dub's book, "Electro-magnetism," to which I have several times referred, you will also find many experiments on the best position of a coil; but it is perhaps sufficient to narrate a single example. Du Moncel had four pairs of bobbins made of exactly the same length, and with 50 metres of wires on each, one pair was 16 centimetres long, another pair 8 centimetres, or half the length, with not quite so many turns, because of course the diameter of the outer turns was larger, one 4 centimetres in length and another 2 centimetres. These were tried both with bar magnets and horseshoes. It will suffice perhaps to give the result of the horseshoe. The horseshoe was made long enough—16 centimetres only, a little over 6 inches long—to carry the longest coil. Now when the compact coils 2 centimetres long were used, the pull on the armature at a distance away of 2 millimetres (it was always the same, of course, in the experiments) was 40 grammes. Using the same

weight of wire, but distributed on the coils twice as long, the pull was 55 grammes. Using the coils 8 centimetres long, it was 75 grammes; and using the coils 16 centimetres long, covering the length of each limb, the pull was 85, clearly showing that, where you have a given length of iron, the best way of winding a magnet to make it pull with its greatest pull, is not to heap the coil up against the poles, but to wind it uniformly, for this mode of winding will give you more turns, therefore more ampère turns, therefore more magnetisation. An exception might, however, occur in some case where there is a large percentage of leakage. With club-footed magnets results of the same kind are obtained. It was found in every case that it was well to distribute the coil as much as possible along the length of the limb. All these experiments were made with a steady current. It does not follow, however, because winding the wire over the whole length of core is best for steady currents that it is the best winding in the case of a rapidly varying current; indeed, we shall see that it is not.

#### EFFECT OF SHAPE OF SECTION.

So far as the carrying capacity for magnetic lines is concerned, one shape of section of cores is as good as another; square or rectangular is as good as round if containing equal sectional area. But there are two other reasons, both of which tell in favour of round cores. First, the leakage of magnetic lines, from core to core is, for equal mean distances apart, proportional to the surface of the core; and the round core has less surface than square or rectangular of equal section. All edges and corners, moreover, promote leakage. Secondly, the quantity of copper wire that is required for each turn will be less for round cores than for cores any other shape, for of all geometrical figures of equal area the circle is the one of the least periphery.

#### EFFECT OF DISTANCE BETWEEN POLES.

Another matter that Du Moncel experimented upon, and Dub and Nicklès likewise, was the distance between the poles. Dub considered that it made no difference how far the poles were apart. Nicklès had a special arrangement made which permitted him to move the two upright cores or limbs, 9 centimetres high, to and fro on a solid bench or yoke of iron. His armature was 30 centimetres long. Using very weak currents he found the effect best when the shortest distance between the poles was 3 centimetres; with a stronger current 12 centimetres; and with his strongest current nearly 30 centimetres. I think leakage must have a deal to do with these results. Du Moncel tried various experiments to elucidate this matter, and so did Prof. Hughes, in an important, but too little-known, research which came out in the *Annales Télégraphiques*, in the year 1862.

#### RESEARCHES OF PROFESSOR HUGHES.

His object was to find out the best form of electro-magnet, the best distance between the poles, and the best form of armature for the rapid work required in Hughes's printing telegraphs. One word about Hughes's magnets. This diagram (fig. 51) shows the

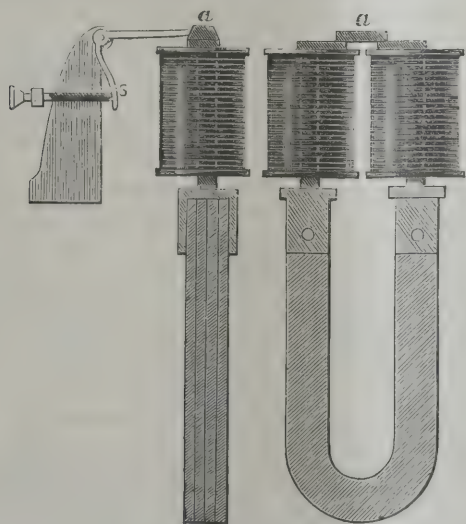


FIG. 51.—HUGHES'S ELECTRO-MAGNET.

form of the well-known Hughes's electro-magnet. I feel almost ashamed to say these words "well-known," because although on the continent everybody knows what you mean by a Hughes's electro-magnet, in England scarcely anyone knows what you mean. Englishmen do not even know that Prof. Hughes has invented a special form of electro-magnet. Hughes's special form is this:—A permanent steel magnet, generally a compound one, having soft iron pole pieces, and a couple of coils on the pole pieces only. As I have to speak of Hughes's special contrivance amongst the mechanisms that will occupy our attention next week, I only now refer to this magnet in one particular. If you wish a magnet to work rapidly, you will secure the most rapid action not when the coils are distributed all along but when they are heaped up near, not necessarily entirely on, the poles. Hughes made a number of researches to find out what the right length and thickness of these pole pieces should be. It was found an advan-

tage not to use too thin pole pieces, otherwise the magnetism from the permanent magnet did not pass through the iron without considerable reluctance, being choked by insufficiency of section; also not to use too thick pieces, otherwise they presented too much surface for leakage across from one to the other. Eventually a particular length was settled upon, in proportion about six times the diameter, or rather longer. In the further researches that Hughes made he used a magnet of shorter form, not shown here, more like those employed in relays, and with an armature from 2 to 3 millimetres thick, 1 centimetre wide, and 5 centimetres long. The poles were turned over at the top towards one another. Hughes tried whether there was any advantage in making those poles approach one another, and whether there was any advantage in having as long an armature as 5 centimetres. He tried all different kinds, and plotted out the results of observations in curves, which could be compared and studied. His object was to ascertain the conditions which would give the strongest pull, not with a steady current but with such currents as were required for operating his printing telegraph instruments; currents which lasted but one to twenty hundredths of a second. He found it was decidedly an advantage to shorten the length of the armature, so that it did not protrude far over the poles. In fact he got a sufficient magnetic circuit to secure all the attractive power that he needed, without allowing as much chance of leakage as there would have been had the armature extended a longer distance over the poles. He also tried various forms of armature having various cross sections.

#### POSITION AND FORM OF ARMATURE.

In one of Du Moncel's papers on electromagnets\* you will also find a discussion on armatures, and the best forms for working in different positions. Amongst other things in Du Moncel you will find this paradox; that whereas using a horseshoe magnet with flat poles, and a flat piece of soft iron for armature, it sticks on far tighter when put on edgewise; on the other hand, if you are going to work at a distance, across air, the attraction is far greater when it is set flatways. I explained the advantage of narrowing the surfaces of contact by the law of traction,  $B^2$  coming in. Why should we have for an action at a distance the greater advantage from placing the armature flatway to the poles? It is simply that you thereby reduce the reluctance offered by the air gap, to the flow of the magnetic lines. Du Moncel also tried the difference between round armatures and flat ones, and found that a cylindrical armature was only attracted about half as strongly as a prismatic armature, having the same surface when at the same distance. Let us examine this fact in the light of the magnetic circuit. The poles are flat. You have at a certain distance away a round armature; there is a certain distance between its nearest side and the polar surfaces. If you have at the same distance away a flat armature having the same surface, and, therefore, about the same tendency to leak, why do you get a greater pull in this case than in that? I think it is clear that if they are at the same distance away, giving the same range of motion, there is a greater magnetic reluctance in the case of the round armature, although there is the same periphery, because though the nearest part of the surface is at the prescribed distance, the rest of the under surface is farther away; so that the gain found in substituting an armature with a flat surface is a gain resulting from the diminution in the resistance offered by the air gap.

#### POLE PIECES ON HORSESHOE MAGNETS.

Another of Du Moncel's researches† relates to the effect of polar projections or shoes—moveable pole pieces, if you like—upon a horseshoe electro-magnet. The core of this magnet was of round iron 4 centimetres in diameter, and the parallel limbs were 10 centimetres long and 6 centimetres apart. The shoes consisted of two flat pieces of iron slotted out at one end, so that they could be slid along over the poles and brought nearer together. The attraction exerted on a flat armature across air gaps 2 millimetres thick, was measured by counterpoising. Exciting this electro-magnet with a certain battery, it was found that the attraction was greatest when the shoes were pushed to about 15 millimetres, or about one quarter of the inter-polar distance apart. The numbers were as follows:—

Distance between shoes. Millimetres.	Attraction in grammes.
2 ... ..	900
10 ... ..	1,012
15 ... ..	1,025
25 ... ..	965
40 ... ..	890
60 ... ..	550

With a stronger battery the magnet without shoes had an attraction of 885 grammes, but with the shoes 15 millimetres apart, 1,195 grammes. When one pole only was employed, the attraction, which was 88 grammes without a shoe, was diminished by adding a shoe to 39 grammes!

#### CONTRAST BETWEEN ELECTRO-MAGNETS AND PERMANENT MAGNETS.

Now I want particularly to ask you to guard against the idea that all these results obtained from electro-magnets are equally applicable to permanent magnets of steel; they are not, for this simple reason. With an electro-magnet, when you put the armature near, and make the magnetic circuit better, you not only get

\* *La Lumière Electrique*, vol. ii.

† *La Lumière Electrique*, vol. iv., p. 129.

more magnetic lines going through that armature, but you get more magnetic lines going through the whole of the iron. You get more magnetic lines round the bend when you put an armature on to the poles, because you have a magnetic circuit of less reluctance, with the same external magnetising power in the coils acting around it. Therefore, in that case, you will have a greater magnetic flux all the way round. The data obtained with the electro-magnet (fig. 42), with the exploring coil, *c*, on the bend of the core, when the armature was in contact, and when it was removed, are most significant. When the armature was present it multiplied the total magnet flow tenfold for weak currents, and nearly threefold for strong currents. But with a steel horseshoe, magnetised once for all, the magnetic lines that flow around the bend of the steel are a fixed quantity, and however much you diminish the reluctance of the magnetic circuit you do not create or evoke any more. When the armature is away the magnetic lines arch across, not at the ends of the horseshoe only, but from its flanks; the whole of the magnetic lines leaking somehow across the space. When you have put the armature on, these lines, instead of arching out into space as freely as they did, pass for the most part along the steel limbs and through the iron armature. You may still have a considerable amount of leakage, but you have not made one line more go through the bent part. You have absolutely the same number going through the bend with the armature off as with the armature on. You do not add to the total number by reducing the magnetic reluctance, because you are not working under the influence of a constantly impressed magnetising force. By putting the armature on to a steel horseshoe magnet you only *collect* the magnetic lines, you do not *multiply* them. This is not a matter of conjecture. A group of my students have been making experiments in the following way. They took this large steel horseshoe magnet (fig. 52) the

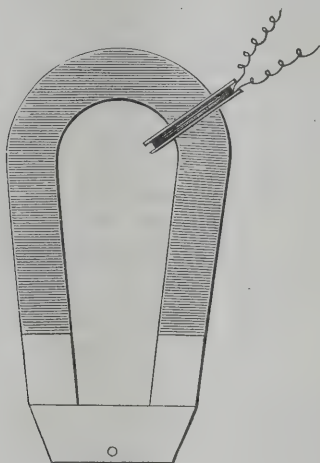


FIG. 52.—EXPERIMENT WITH PERMANENT MAGNET.

length of which from end to end through the steel is  $42\frac{1}{2}$  inches. A light narrow frame was constructed so that it could be slipped on over the magnet, and on it were wound 30 turns of fine wire, to serve as an exploring coil. The ends of this coil were carried to a distant part of the laboratory, and connected to a sensitive ballistic galvanometer. The mode of experimenting is as follows:—The coil is slipped on over the magnet (or over its armature) to any desired position. The armature of the magnet is placed gently upon the poles, and time enough is allowed to elapse for the galvanometer needle to settle to zero. The armature is then suddenly detached. The first swing measures the change, due to removing the armature, in the number of magnetic lines that pass through the coil in the particular position.

I will roughly repeat the experiment before you: the spot of light on the screen is reflected from my galvanometer at the far end of the table. I place the exploring coil just over the pole, and slide on the armature; then close the galvanometer circuit. Now I detach the armature, and you observe the large swing. I shift the exploring coil, right up to the bend; replace the armature; wait until the spot of light is brought to rest at the zero of the scale. Now, on detaching the armature, the movement of the spot of light is quite imperceptible. In our careful laboratory experiments, the effect was noticed inch by inch all along the magnet. The effect when the exploring coil was over the bend was not as great as  $\frac{1}{30000}$ th part of the effect when the coil was hard up to the pole. We are therefore justified in saying that the number of magnetic lines in a permanently magnetised steel horseshoe magnet is not altered by the presence or absence of the armature.

You will have noticed that I always put on the armature gently. It does not do to slam on the armature: every time you do so, you knock some of the so called permanent magnetism out of it. But you may pull off the armature as suddenly as you like. It does the magnet good rather than harm. There is a popular superstition that you ought never to pull off the keeper of a magnet suddenly. On investigation, it is found that the facts are just the other way. You may pull off the keeper as suddenly as you like; but you should never slam it on.

From these experimental results I pass to the special design of electro-magnets for special purposes.

(To be continued.)

## PROCEEDINGS OF SOCIETIES.

### The Institution of Electrical Engineers.

Read Thursday, November 13th.

"Notes on the Chemistry of Secondary Cells." By Prof. W. E. AYRTON, Vice-President; C. G. LAMB, B.Sc., and E. W. SMITH, Associates.

I.

In our paper on "The Working Efficiency of Secondary Cells," read at the meeting of this Institution in Edinburgh in July, it was stated that, "In spite of accumulators with pasted plates having been in use now for nine years, the chemical action that takes place during the different stages of the charge and discharge has only been conjectured, and, odd as it seems, no decisive experiment appears to have been made to settle this much-debated question. Various analyses have been made by different chemists of salts of lead acted on in certain ways with sulphuric acid, but apparently not of actual accumulator plates in action. We are therefore now, with the assistance of Mr. Robertson, making a complete investigation of the chemical state of the plugs of both the positive and negative plates at all stages of the charge and discharge of an 1888 E.P.S. type of accumulator in good condition." The present paper contains an account of the results thus obtained.

The cell selected to remove the plugs from had the same size as the cells employed in the investigations described in the previous communication, and was one of the batch of 50 purchased for the Central Institution about the middle of 1888. Since it first came into our possession it had never been overcharged, never been left discharged, nor permitted to send more than the maximum current allowed by the makers for cells of this size—viz., 10 amperes—and consequently, at the beginning of the present investigation in June of this year, this cell was in excellent condition.

First the cell was several times charged with a current of 9 amperes, and discharged with a current of 10, without stopping day or night, so as to bring it into what we have called its steady "working" state. The dotted curves, figs. 1 and 2, show the large charge and discharge obtained on June 28th. During the next charge, indicated by the continuous curve, fig. 1, plugs were removed from both the positive and negative plates at the points marked A, B, C, and D, when the terminal P.D. of the cell was 2.134, 2.2, 2.234, and 2.4 volts respectively. In order to remove the plugs from the positive plates, these plates were bodily removed out of the liquid, but, to prevent oxidation, the negative plates were left in the liquid, and the plugs removed in a way that will be described later on. The time occupied in removing the plugs from the two sets of plates occupied about 15 to 20 minutes on each occasion. Immediately after the removal of the plugs the positive plates were put back in position in the cell, the resistance in the circuit rapidly adjusted, if necessary, to make the charging current exactly 9 amperes, and the time variation of the P.D. at the terminals of the cell noted. The interval that elapsed while the current was broken is not shown on the curve; that is to say, the P.D. observed immediately after replacing the positive plates in the liquid and closing the circuit is plotted directly under the P.D. that was observed just before the circuit was broken, prior to the removal of the positive plates from the liquid.

We were afraid that the bodily withdrawal of the positive plates out of the liquid, combined with the removal of the plugs, on the several occasions, would produce so great a change in the conditions of the cell as to render the P.D. curve quite discontinuous. It was, therefore, as interesting as it was unexpected, to find that the terminal P.D., on restarting the normal charging current of 9 amperes, rapidly acquired the value it had before the withdrawal of the plates; so that, with the exception of the rapid rise of the P.D. on restarting the charging current, the P.D. curve obtained on June 29th was almost the same as the P.D. curve obtained on charging on the previous day.

After the cell had been charged until the terminal P.D. reached 2.4 volts, it was immediately discharged with a perfectly constant current of 10 amperes, and, as it was anticipated that the removal of the plugs would spoil the cell, it was allowed to discharge far below the normal limit. In previous discharges (the last one of which is shown by the dotted line, fig. 2), the discharge was stopped when the terminal P.D. fell to 1.85 volts. But in the discharge on June 30th, when the plugs were removed, the discharge current was kept at 10 amperes, by using auxiliary cells, until the E.M.F. of the test cell fell to nought, and even reversed. Plugs were removed from both the positive and the negative plates when the terminal P.D. was 2, 1.95, 1.85, 0.6, and nought volts, as indicated by the points A', B', C', D', and E'. The recovery of the E.M.F. on breaking the circuit was very marked, especially near the end of the discharge.

II.

#### METHOD OF OBTAINING SAMPLES OF THE PLUGS.

On the first removal of plugs corresponding with the point A fig. 1, a curved pointed glass rod was used, as shown in fig. 3, with the idea of prising out the plugs; but by this method only the surface of the positive plugs could be removed, as they were much too hard to be loosened in this way. Indeed, one of the most striking things noticed in this investigation was the firm

way in which the plugs were held in the plates of an E.P.S. cell that had been carefully used for two years. Before the next attempt was made to remove plugs corresponding with the point B, fig. 1, a straight piece of glass rod was pointed, and mounted in a wooden handle. This glass chisel was used to pierce and loosen the positive plugs, which were then driven bodily out of the grid by means of a hard wooden punch cut square to fit the holes in the grid, and which was tapped with a small mallet. The plugs on being driven out of the grid were caught in a long wooden scoop (shaped so that it could be just slipped in between the plates), and then washed by Mr. Robertson into wide-mouthed bottles containing three or four hundred c.c. of distilled water. As soon as the water cleared it was decanted off and fresh added.

handle, as shown in fig. 4. It was possible to use this method throughout for the removal of the negative plugs, as they were softer and more easily removable than the positive ones. The scoop held sufficient liquid to enable the negative plugs to be dropped into wide-necked bottles containing water without the plugs being even momentarily exposed to the air. The water in these bottles Mr. Robertson had washed free from dissolved oxygen by previously bubbling hydrogen through it for a considerable time. After the negative plugs had been put into the bottles the water was gradually decanted off from time to time, and fresh added until the liquid in the bottle was quite free from acid.

Both in the case of the positives and the negatives the top

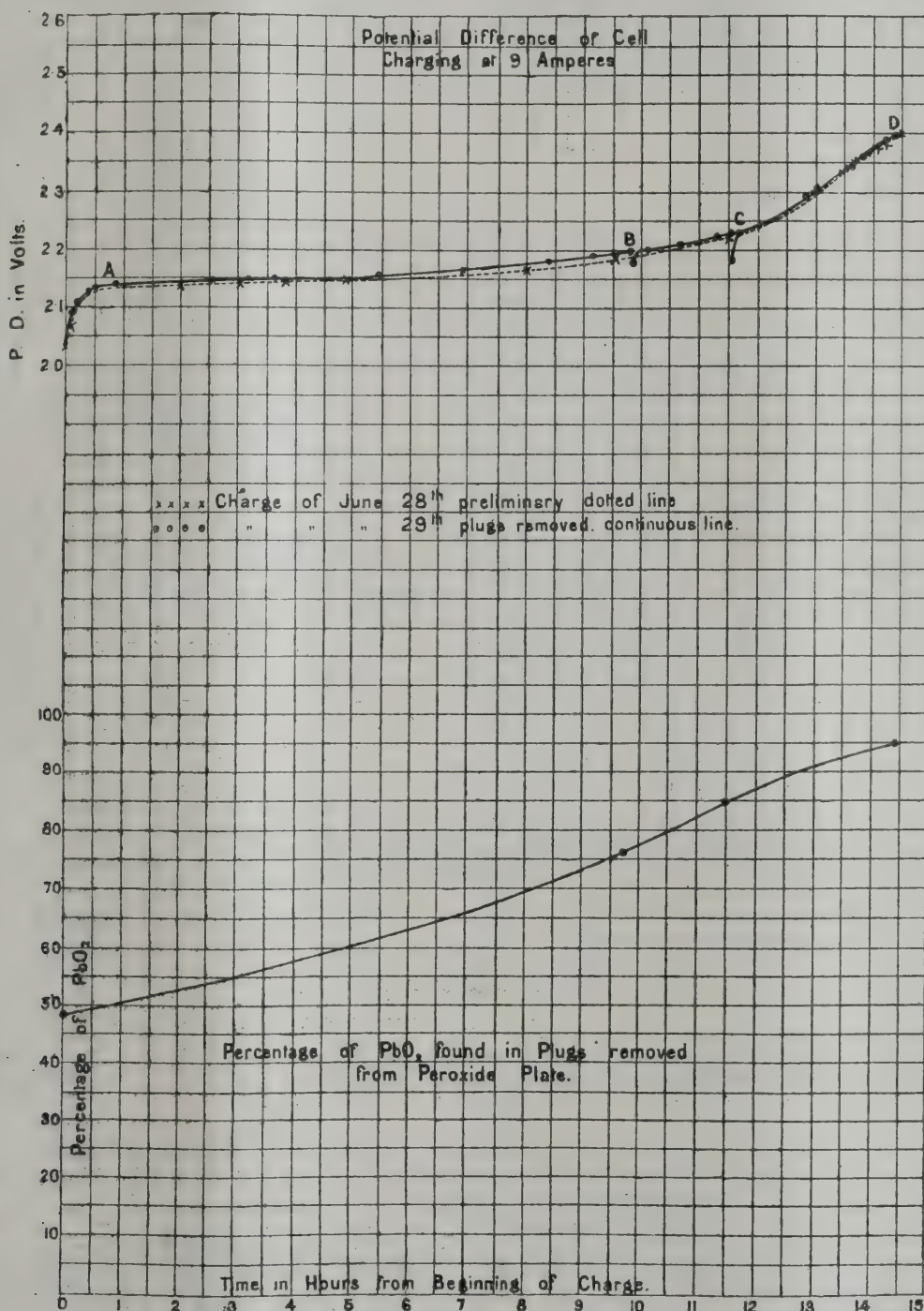


Fig. 1.

As several glass chisels were broken, and the wooden punches worn down in the removal of the plugs, the method has the disadvantage of mixing with the specimens to be analysed splinters of glass and wood, which were found difficult to remove afterwards. On the other hand, the method had the advantage of enabling specimens of the positive plugs to be removed in a comparatively short time on each occasion from the top, the middle, and the bottom of the plates.

As the negative plates were never removed from the acid, the only way to remove the plugs was by working them loose under the liquid by means of long curved glass rods pointed at the end, and by catching the plugs in a narrow wooden scoop with a long

samples were removed from the corner of the plates nearest the lug, and the bottom samples from the corner diametrically opposite, so as to obtain evidence, if possible, of any difference of current density which might exist at different parts of the plates in charging and discharging.

The plugs from the top, the middle, and the bottom of each set of plates were at each of the removals of plugs put into six separate bottles; and, to avoid the possibility of error in their subsequent identification, there was noted on the label of each the character of the plates and the position on them from which the plugs were removed, the time, the P.D., and the specific gravity of the liquid in the cell.

III.

APPEARANCE OF PLATES AT REMOVALS OF PLUGS.

The following notes were made by Mr. Robertson and ourselves at the successive removals of the plugs:—

Point c on Curve 1. Terminal P.D., 2.234 volts. Specific Gravity of Liquid, 1.201.

The previous charges increased in amount. The previous charges increased in amount.

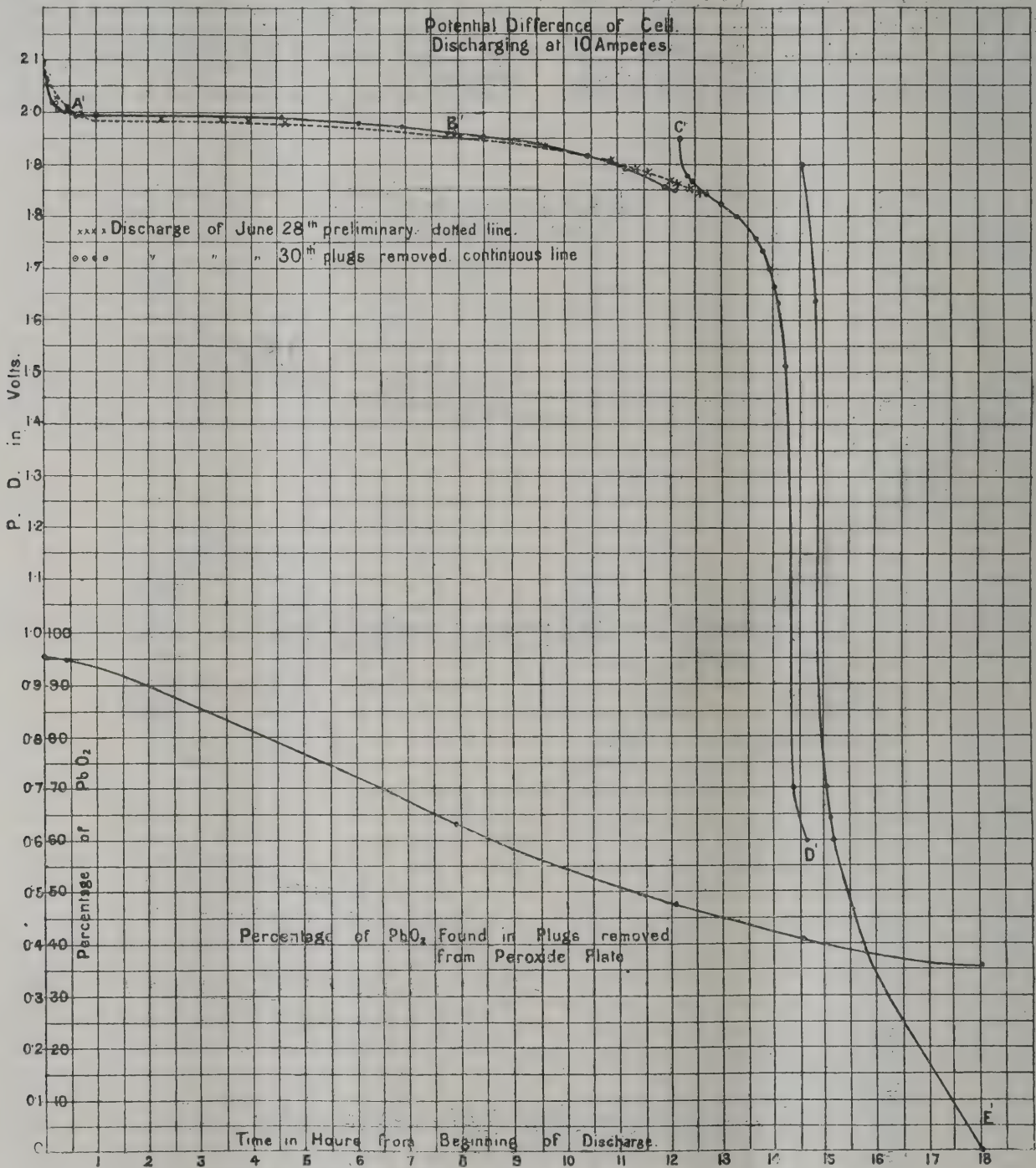


Fig 2.

CHARGING.

POSITIVE PLATES.

NEGATIVE PLATES.

Point A on Curve 1. Terminal P.D., 2.134 volts. Specific Gravity of Liquid, 1.178.

The upper part of the plates had a greyish-brown colour, and presented the appearance of being coated with a very thin film of white sulphate. The lower part of the plates was of a reddish-brown colour.

The plugs at the top were hard, while those at the bottom were quite soft.

Point B on Curve 1. Terminal P.D., 2.2 volts. Specific Gravity of Liquid, 1.198.

The plates had entirely lost their whitish appearance, and showed a uniform reddish-brown colour, darker than the previous colour of the bottom of the plates.

The plugs at the top were the softest.

The plugs both at the top and at the bottom harder than before, those at the top having hardened more than those at the bottom.

Point D on Curve 1. Terminal P.D., 2.4 volts. Specific Gravity of Liquid, 1.206.

The plates had the rich deep brown colour of lead peroxide, except where they were covered with the ebonite separators: there the colour was lighter.

The plugs at the top were slightly the softest, while those at the bottom were much the same as at the beginning.

The plugs had a brilliant metallic lustre, and looked quite silvery when first removed from the plates. The plugs at the top now were the hardest.

DISCHARGING.

POSITIVE PLATES. NEGATIVE PLATES.

Point A' on Curve 2. Terminal P.D., 1.993 volts. Specific Gravity of Liquid, 1.205.

The plugs at the top were harder than those at the bottom.

The plugs had the brilliant metallic lustre observed at the end of the charging.

Point c' on Curve 2. Terminal P.D., 1.850 volts. Specific Gravity of Liquid, 1.180.

The plugs had become much harder.

The plates had become decidedly white, and the plugs were white right through.

Point D on Curve 2. Terminal P.D., 0.6 volt. Specific Gravity of Liquid, 1.175.

The plugs had become extremely hard, especially at the bottom.

The plugs were somewhat softer.

Point E on Curve 2. Terminal P.D., 0 volt. Specific Gravity of Liquid, 1.172.

The plugs had become so hard that they splintered and bits flew about on trying to remove them.

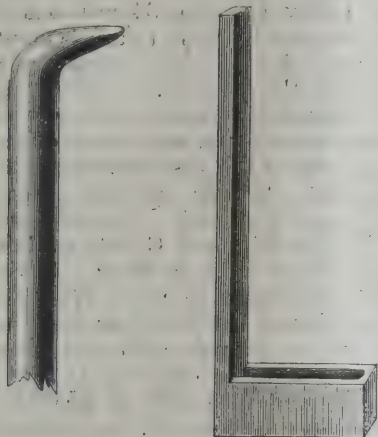


FIG. 3.

FIG. 4.

The bubbling of gas from the negative plates ceased when the terminal P.D. on discharging fell to 1.85 volts (point c' on curve 2), and it began again when the terminal P.D. fell to somewhere near zero.

FIG. 5.—Charging

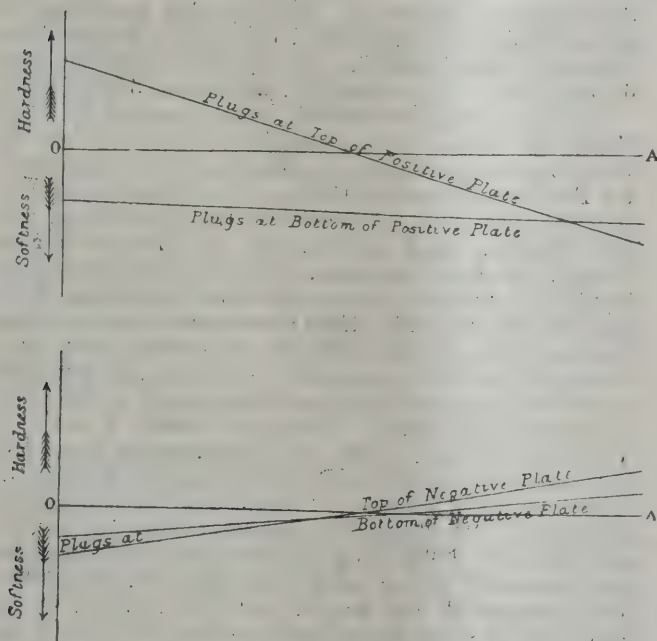


FIG. 6.

The following figures (5 and 6) give an idea of the way in which we found the hardness of the top and bottom plugs of the positive and the negative plates respectively to vary during a normal charge. The figures are not drawn to scale, as we had no standard of hardness beyond our sensations, hence the figures only profess to be qualitative sketches from which mental pictures can be obtained. Distance measured upwards from o A indicates roughly the degree of hardness; distance measured downwards the degree of softness.

It will be seen that during the charging the variation in the hardness of the plugs is far greater at the top than at the bottom of the plates, and consistently with this fact Mr. Robertson's analyses show that, on the whole, the rate of chemical action

at the top of the plates is greater than at the bottom. The difference in the hardness, however, is far more marked than the difference in the chemical action. For example, while the plugs at the top of the positive plates are, during the earlier part of the charging, much harder than those at the bottom, no such striking difference is observable in the percentage of lead peroxide contained by these plugs. The cause of this we are examining experimentally at the present time.

In order to see how far the resistance of the lead grid would tend to make the current density in the upper part of the liquid less than in the lower, as well as for the purpose of seeing how large a fraction of the whole resistance of the accumulators was due to the lead lugs and to the connections between the successive pairs of lugs, the following tests were made by three of the students—Messrs. Hobson, Lee, and Montealegre:—

Parts of the lead lugs of some of the accumulators were scraped, and on these clean spots binding screws, which had been themselves filed bright, were tightly screwed. The accumulators were allowed to send measured currents, the values of which are given in the following tables, and the P.D. between the pairs of binding screws was carefully measured with a sensitive reflecting voltmeter. The resistance of the lugs between the pairs of binding screws is then at once obtained by dividing the P.D. by the current.

(To be continued.)

### The Royal Society.

"Magnetism and Recalescence." By J. HOPKINSON, D.Sc., F.R.S.

IN my experiments, the results of which are published, "Phil. Trans," 1889, A, p. 443, I showed that recalescence and the disappearance of magnetisability in iron and steel occurred at about the same temperature. The evidence I then gave was sufficiently satisfactory, but did not amount to absolute proof of the identity of the temperatures. Osmond has shown that the temperature of recalescence depends upon the temperature to which the iron has been heated, also that it differs when the iron is heated and when it is cooled. He also showed that for some sorts of steel the heat is liberated at more than one temperature, notably that in steel with 0.29 per cent. of carbon, heat is liberated when cooling at 720° C. and at 660° C., and that with steel with 0.32 per cent. carbon there is a considerable liberation of heat before the temperature is reached when this becomes a maximum. It appeared to be desirable to obtain absolute proof that the change of magnetic property occurred exactly when heat was liberated and absorbed, and to examine, magnetically, Osmond's two temperatures of heat liberation. I have not been able to obtain samples of steel of the size I used, showing two well marked temperatures of heat liberation and absorpition, but I have a ring in which there is liberation of heat extending over a considerable range of temperature.

The samples had the form of rings. A copper wire was well insulated with asbestos, and laid in a groove running round the ring, and was covered with several layers of asbestos paper laid in the groove. This coil was used for measuring temperature by its resistance. The whole ring was served over with asbestos paper and with sheets of mica. The secondary exploring coil was then wound on, next a serving of asbestos paper and mica, and then the primary coil, and, lastly, a good serving of asbestos paper was laid over all. In this way good insulation of the secondary coil was secured, and a reasonable certainty that the temperature coil took the precise temperature of the ring, and that at any time the ring was throughout at one and the same temperature. The whole was placed in an iron pot, and this again in a Fletcher gas furnace. Observations were made of temperature as the furnace was heating, and from time to time of induction. In each case the time of observation was noted. Similar observations were made as the ring cooled, the furnace being simply extinguished. We are thus enabled to compare directly at the same instant the condition of the same ring as regards magnetism and as regards temperature, and, therefore, qualitatively as regards its absorption or liberation of heat.

The results for a ring containing 0.3 per cent. of carbon or thereabouts show that there is a considerable liberation of heat, beginning at 2 h. 12 m., temperature 715° C., and continuing to time 2 h. 22 m., temperature 660° C., being apparently somewhat slower at the end. This may, however, be only apparently slower as the furnace temperature would fall lower in relation to the ring. At time 2 h. 22 m., temperature 660° C., the rate of liberation becomes much more rapid, so much so that the temperature for a time remains almost stationary. At time 2 h. 29 m. the liberation of heat appears to have ceased, and the normal cooling to continue. Now, comparing the kicks of the galvanometer, which are proportional to the induction, it is observed that the ring begins to be magnetisable at time 2 h. 12 min., its magnetic property increases till time 2 h. 22 m.; after this point the magnetisability increases much more rapidly, and is practically fully developed at 2 h. 31 m. In this case the development of magnetic property follows precisely the whole of the liberation of heat, observed both at the temperature of about 700° C. and at 660° C. We may, therefore, be certain, that both at the higher and lower temperatures of recalescence there is magnetic change, and that the one is as much dependent on the other as the solid condition of ice is upon the liberation of heat when water solidifies. The two changes occur, not only at the same temperature, but simultaneously. A considerable magnetising force, 6.56, was taken, as it was expected and found that the magnetic property would

then be more apparent when it was in the intermediate condition between the two temperatures of recalcence.

The results of a ring containing 0.9 per cent. of carbon show that there is a slight absorption of heat at time 11 h. 17 m., temperature 710° C., with doubtful effect on the magnetism. At time 11 h. 27 m., temperature 770° C., powerful absorption of heat begins and continues to time 11 h. 55 m., temperature 808° C.; it is between these times that the magnetisability is decreasing, and at the latter time that it finally disappears. The heating was continued to about 840° C., and the flame was then put out. In cooling, heat is liberated at one point only, and in this case with a distinct rise of temperature. The recalcence begins at time 3 h. 47 m., temperature 750° C., and it is precisely at this time that the ring begins to be magnetisable. The recalcence continues to time 4 h. 8 m., and at this time, and not before it, the magnetisability practically attains a maximum. Before the last portion of the curve the ring was heated to 966° C. Here no observations were made magnetically. This part of the curve, therefore, only shows the effect of higher heating in lowering the temperature of recalcence. Unfortunately I had forgotten to record the magnetising force; it was, however, much less than in the last case, probably less than unity.

These experiments show that the liberation and absorption of heat, known as recalcence, and the change in magnetic condition, occur simultaneously. Also that in the case of steel with 0.3 per cent. of carbon both temperatures of liberation of heat are associated with change of magnetic condition.

#### Physical Society.—November 14th, 1890.

Prof. W. E. AYRTON, F.R.S., President, in the chair.

The following communication was made:—

"Tables of Spherical Harmonics, with examples of their Practical Use." By Prof. J. PERRY, F.R.S. The author defined a spherical harmonic as a homogeneous function of  $x, y, z$ , satisfying the

equation  $\frac{d^2 v}{dx^2} + \frac{d^2 v}{dy^2} + \frac{d^2 v}{dz^2} = 0$ , stated the fundamental pro-

perties of such functions, and pointed out their importance in problems on heat, electricity and hydro-dynamics. Referring to zonal harmonics (homogeneous functions of  $(x^2 + y^2)^{1/2}$  and  $z$ ), he showed that these harmonics are symmetrical with respect to the axis of  $z$ , and might be expressed as functions of the angle ( $\theta$ ) which the line joining the point  $(x, y, z)$  to the origin makes with the axis of  $z$ , multiplied by  $r^i$ ; where  $r$  is the radius vector and  $i$  the degree of the homogeneous function. These functions of  $\theta$  are called zonal surface harmonics, and are designated by  $P_0, P_1, P_2$ , &c., according to the degree of the function, and it was the values of these quantities which form the tables brought before the society. The tables comprise the values of  $P_1$  to  $P_8$ , and are calculated to four places of decimals and for every 1° between 0° and 90°.

As an example of such tables, the case of a spherical surface covered with attracting matter whose density varied as the square of its distance from a diametral plane, was taken. It was required to find the potential both outside and inside the sphere, and to determine the equipotential surfaces and lines of force. The potentials inside (A) and outside (B) were shown to be given by

$$\frac{A}{\pi} = 8 + \frac{16}{5} r^2 P_2 \text{ and } \frac{B}{\pi} = \frac{8}{r} + \frac{16}{5} \frac{1}{r^3} P_2 \text{ respectively.}$$

By giving A and B definite values and choosing values of  $r$ , the corresponding  $P_2$  can be calculated and the value of  $\theta$  determined from the tables. Hence any equipotential surface can be easily determined and lines drawn to cut these surfaces orthogonally are the lines of force.

Another problem which had been tried consisted in finding the directions of the lines of force near a circular coil of rectangular cross-section when an electric current circulates in the coil. This was treated approximately by first calculating the potential at 6 points along the axis in the neighbourhood of the coil and then finding by Gauss' method the coefficients,  $A_0, A_1, A_2$ , &c., of an expression in ascending powers of  $z$ , which agreed with the calculated potentials at the points chosen. The formula

$$V = A + A_1 r P_1 + A_2 r^2 P_2 + \text{&c.},$$

or its corresponding expression in inverse powers of  $r$  was then assumed to give the potential at any point in the space considered. By giving  $v$  definite values, a series of equipotential surfaces were determined and the lines of force drawn. On putting the calculations to the test of experiment, the approximate solution of this very difficult problem was found to be very nearly correct.

**The John Pender Gold Medal.**—The Electrical Engineering Gold Medal, presented annually by Sir John Pender, K.C.M.G., through Prof. Jamieson, to the Glasgow and West of Scotland Technical College, has been gained by Arthur H. Allen, who, besides taking the first place in all his college classes, took the first place in the kingdom with first class honours at the Science of Arts Public Examinations, and first class honours at the City and Guilds of London Institute Technological Examinations.

#### CITY AND GUILDS OF LONDON INSTITUTE.

THE annual distribution of prizes and certificates gained by students attending the various colleges of the Institute, took place at Clothworkers' Hall last Wednesday evening. The Right Hon. the Lord Mayor presided, and, in the course of his opening remarks, said it was both his duty and privilege to take part in so important a work as encouraging the spread of technical education. The question had become of vital importance, and it was only too evident that in the past elementary education had been of too academical a character; book-learning had been sought after, while the more important training of hand and eye had been greatly neglected. With the population increasing rapidly, very likely reaching 34 millions at the next census, it was impossible to find employment for all in this country, and while it was absolutely necessary that we should look to the colonies, it was important to remember that for colonists clerks were not required, but bricklayers and carpenters, and others who could use tools and make use of the vast resources nature placed at their disposal. If our national supremacy was to be maintained, technical education was essential to that end, and the City and Guilds of London Institute had been doing what it could. In September of last year there were twice as many applications for admission to the Central Institution as there had been the year before, and to provide sufficient accommodation for the increased number of students the laboratories were being enlarged at a cost of £5,000. Important researches had been carried out, one worthy of mention being that of Prof. Ayrton and his third-year students, on the "Efficiency of Secondary Cells." At Finsbury College the number which had passed the entrance examination was in excess of the number which the college could accommodate, and extensions had been rendered necessary. As a preliminary and temporary measure, a warehouse had been rented, into which the mechanical department would have to move. At the South London School of Technical Art there were at present 103 students, against 78 last year. At the Technological examinations, held by the Institute, over 6,000 students were examined, while over 3,000 passed.

The prizes and certificates were presented by Lord Cross, the names of the students being read out by Prof. Unwin for Central Institution, Prof. Thompson for Finsbury Technical College, Mr. Sparks, superintendent of studies, for the South London School, and Mr. Burdett, head master, for the Leather Trades School. The Lady Mayoress, who was present, smilingly handed the prizes to the successful lady students. After distributing the prizes, Lord Cross gave a short address on the work of the Institute, remarking that, as a liveryman of the Clothworkers' Company, he was glad to say that they had not been behind-hand in the cause of technical education. There was hardly a town in Yorkshire, he said, where the Clothworkers' Company had not been instrumental in establishing classes for technical instruction in connection with the textile industries. Reviewing the history of the subject, he said that, in conducting technological examinations, they were only doing what their ancestors, the masters and wardens of the guilds, had done, when, on an apprentice serving seven years to his trade, they examined his "masterpiece," to determine whether he might be admitted as a master craftsman. Though, with the age, the character of the examination had changed, in extent and object it was still the same. It was a mistake to suppose that they wanted to substitute the technical school for the workshop, for in the nature of things that was impossible, but he held that a workman who had a scientific reason for everything he did was a better workman than one who hadn't, and this reason the technical school endeavoured to supply.

After the usual votes of thanks had been proposed and responded to, the audience adjourned to the refreshment rooms to find further evidence of the liberality of the Clothworkers' Company.

## NOTES.

**Electric Light in Whitechapel.**—The electric light is penetrating into the East End. The Laing, Wharton and Down Construction Syndicate having applied to the Whitechapel Board for the granting of a provisional order, this body referred the matter to a committee, who reported in favour of the board taking the electric lighting of the district into its own hands. The clerk made a statement, from which it appeared that by improvements shortly to be made in a destructor they have erected, there would be waste heat sufficient to generate 100 horse-power of steam, which power it was proposed to apply to the working of dynamos sufficient to light a small area as an experiment. The Whitechapel Board will apply to the Board of Trade for a provisional order.

**Proposed Pacific Cable.**—The *Montreal Gazette*, of November 5th, calls attention to an error into which the *Globe* has fallen with regard to the originator of the trans-Pacific cable scheme. The *Globe* attributes the conception of the idea to Mr. Sandford Fleming, whose proposed route connected Canada with the Fiji and Sandwich Islands and Australia. Prior to this, however, it is stated that Mr. Gisborne, the Superintendent of the Dominion Government Telegraphs, had suggested a cheaper and better route *via* Japan and China. These views were published, accompanied by a chart explanatory of the various schemes, in the *Dominion Illustrated*, of 6th April, 1889. The main idea of Mr. Gisborne's route is apparently the connection with such industrially-important countries as Japan and China, instead of with unprofitable localities such as the Pacific Islands, and his scheme possesses the additional advantage of shorter sections than contained in either of the other routes advocated. As observed by the *Gazette*, priority of idea is not a matter of so much moment, excepting for the sake of such kudos as may be adjudged to the originator of the scheme. The important question is which of the proposed routes is most likely to find the greater number of supporters and the most influential partisans. There seems to be no great difficulty, other than from a financial point of view, attached to the carrying out of either of the suggested systems.

**Use of the Telegraph.**—Telegraph statistics for 1888 show that in the United Kingdom for every 100 inhabitants 140 telegrams were sent. France comes very close to this figure with 136 messages, but Germany is a long way behind with only 35. Italy follows with 20 telegrams, Austria-Hungary with 18, and Russia with only 2. "Is not the use of the telegraph," asks the *Lumière Electrique*, "a positive indication of the spread of civilisation, the progress of industries, and, to an extent, an estimate of intelligence?"

**Woodhouse and Rawson, Limited.**—On Tuesday a statutory meeting of the shareholders of this company was held at the offices in Bradford for the purpose of receiving an account of the reasons which led to the winding-up of the company, and passing a resolution of approval. Only three shareholders put in an appearance, namely, Mr. G. A. Steinthal, Colonel Harrison and Mr. J. Leach. Reporters were not admitted, and were informed that no statement of accounts would be supplied to them. A formal resolution of approval was, we understand, passed.

**Critical America.**—We notice in the New York *Electrical Engineer*, a leading article directed at our recent comments on the electro-deposition of copper. Were it not that such a thing seems impossible we should be apt to imagine that our contemporary had been inspired from this side, but we shall deal more fully with the criticisms of our American cousins in a future issue and endeavour to show that instead of being misleading, our deductions will be found correct even in trans-Atlantic eyes.

**Carbon Shields for Arc Lamps.**—If we are not very much mistaken, the Siemens's arc lamps of, say, 10 or 12 years ago, had a sheath on the lower carbon similar to that which Mr. Hazeltine employs on his upper electrode (see p. 643). Its object was, we believe, a different one; but it would be interesting to know whether any saving of carbon was effected by its use.

**Electrically-fired Mitrailleuses.**—To our readers who are connected with the War Office, the description of an electrically-fired Gatling gun will prove highly interesting, and it is more than probable that in the future there will be a great field for the employment of small electro-motors for such purposes on ship-board.

**Electric Supply Companies in Court.**—London Electric Supply Corporation *v.* Crookshank.—The plaintiffs, on Wednesday, sought to recover £167 for six months' supply of electric current to the Pall Mall Club. The plaintiffs' case was that when at the end of 1887 they had arranged to supply the club at £1 per 10-candle lamp, it was further agreed that the supply should eventually be by meter. They now claimed for six months' supply at meter value. The defendant denied having made any such agreement, and paid a sum into court on the old scale of charges.

His Lordship, in delivering judgment, said it was much to be wished that people would put their agreements into writing. The plaintiffs had no note or memorandum, and their evidence was of an exceedingly hazy character. They failed because of the careless manner in which they did business. He did not find that there was any agreement to pay by meter scale, and his judgment would be for the defendants with costs.

**Dickens and Jones *v.* Metropolitan Electric Supply Company, Limited.**—In this action, on the same day, Messrs. Dickens and Jones, of Regent Street, sought to recover damages for alleged breach of contract to supply electric light to their premises. The defendants denied that there was any written agreement, and pleaded alternatively that if they had entered into any agreement at all, it was an agreement at will only, and made subject to a proviso that the defendants were not to be liable to any damage by accidental interruptions. They pleaded that if the supply had been interrupted, it was accidentally, and by reason of the overhead wires being in an unsafe condition at a period when they could not enter upon the district in which the plaintiffs' premises were situate, for the purpose of replacing them. For the same reason they contended that they were prohibited from supplying the plaintiffs any longer, and only continued to do so by the sufferance of the Board of Trade. They stated, further, that when under the new regulations of the Board of Trade, consequent upon the new Electric Lighting Act, their supplying cable had become insufficient, they had written plaintiffs, offering to provide and fix suitable plant at their cost, which offer had been refused.

In reply, plaintiffs pleaded that, under Section 6 of the Act, defendants were permitted to continue supply until September 29th, 1890.

Evidence was given that, prior to 1888 the plaintiffs had been supplied by the Grosvenor Gallery, and subsequently by Messrs. Pritchett & Co., and that when the business was purchased by the defendant company the supply of electric energy was continued under a somewhat similar contract. It appeared, however, that though a draft agreement had been submitted to Messrs. Dickens and Jones by Messrs. Pritchett & Co., and that though the plaintiffs on taking over the business had sent defendants a printed form of agreement, neither had been signed, and Mr. Lumley Smith, for the defendant, submitted that there was no evidence of any express agreement, and that the electric energy had only been supplied and received at the respective wills of supplier and consumer, and could be terminated by either party without notice.

With this view Mr. Justice Stephen agreed. He nonsuited the plaintiffs, and granted a stay of execution for six days pending appeal.

**Forging Telegrams.**—Henry Ives, the clerk who was convicted at the last sessions of the Central Criminal Court of forging a telegram, to whose case we referred at the time, was on Wednesday last brought up for judgment. Mr. Purcell addressed the court on his behalf, and the Recorder sentenced him to nine months' imprisonment with hard labour, to date from the date of his conviction.

**Overhead Conductor Regulations.**—The memorials which have been sent to the Board of Trade by four important electrical firms are well-timed, but they might have been couched in more vigorous terms. It is almost time that the relations existing between the technical advisers to the Board and the electrical trades should be dealt with in a forcible manner.

**Fatal Electric Shocks.**—The opponents of electrical execution may perhaps change their views as to the efficacy of the method if they ponder for a while on the fatal accident which we record to-day in our "Communications from Austria-Hungary." There have been so many practically instantaneous deaths from electrical shocks accidentally contracted, that it seems too absurd to think that we shall have a repetition of the Kemmler affair as reported, although we have never been amongst those who gave credence to the harrowing details of that death-scene. The approaching end of the Japanese who now awaits the carrying out of a sentence similar to Kemmler's will probably settle once and for all the conflicting opinions which exist on the subject.

**The National Telephone Electrical Society (Midland Branch).**—The first meeting for the Session 1890-1 of this society met at Birmingham on Friday evening last (November 21st, 1890), when the President, Mr. Coleman, M.I.E.E., delivered a highly interesting address on "Telephony at the Present Time." There was a large attendance, members from outlying centres being present.

**The Royal Society.**—Last night Messrs. G. J. Burch and V. H. Velej were down for reading a paper on "The Variations of Electromotive Force of Cells consisting of Certain Metals, Platinum, and Nitric Acid."

**Electric Lighting by Gas Companies.**—It is said from March, 1889, to March, 1890, the American gas companies increased their ownership in the electric lights to the extent of almost 50 per cent.

**Electric Light Accidents in America.**—James Tucker, a foreman lineman of the East River Electric Light Company, while repairing wires in a New York street, fell upon the wires, and died shortly after.

An *employé* of the electric light company at San Francisco has received a shock which is calculated at fully 1,000 volts. The man escaped with his life, but his hands are burned to the bone.

**Lecture to Nurses.**—A lecture to nurses on medical applications of electricity (with demonstrations on living subjects) will be given on December 11th, by Mr. Newman Lawrence, at the Institute of Medical Electricity, 35, Fitzroy Square, W.

**Prospects of Electric Light in Paris.**—M. Fontaine thinks that in 1891 or 1892 the electric lighting in Paris will require for its production motive force equal, in round numbers, to 32,000 horse-power.

**Canadian Telephones.**—It is said that there are about 25,000 telephones in use in Canada, of which more than 20,000 belong to the Bell Telephone Company.

**Overhead Wires.**—The London County Council will shortly apply for leave to bring in a Bill for the regulation and control—and, if need be, removal—of overhead wires.

**The Woking Electric Supply Company.**—The directors are about to make a further issue of shares. There are to be 400 new shares of £5 each, issued for the purpose of providing a working capital. Several residents in the district have expressed a wish to become shareholders in the company, and the directors, realising the importance of obtaining local support, have decided to offer these shares in the first place in this locality only. The total capital authorised is £20,000.

**Provisional Orders.**—The London *Gazette* publishes notices of the corporate authorities of the following places who will shortly apply to the Board of Trade for provisional orders under the Electric Lighting Act:—Coventry, Southport, Ealing, Monmouth, Bolton, Kidderminster, Bromley, Croydon, Torquay, Chiswick, Stockport, Leamington, Weston-super-Mare, Cardiff, Canterbury, and Exeter. Scarborough will apply for the renewal of an order already existing, and public companies will apply for power to supply the following places: Newcastle-upon-Tyne, Weybridge, Westminster, Norwich, Exeter and St. Luke's, Chelsea and St. George's, Hanover Square.

**The Electro-Harmonic Society.**—The amateur concert (ladies' night) will take place on Monday evening, December 8th, and the programme may be seen in our supplement. Members will note with great pleasure that Mrs. Alexander Siemens has again kindly consented to sing, and a new amateur violinist in the person of Mr. Theodor Raaschon, will appear for the first time, to play one of Vieuxtemps' most celebrated and exacting compositions. With the exception of the baritone, Mr. Gordon Heller, and the youthful humorist, Mr. F. Charlton Fry, a son of that well-known elocutionist Mr. Chas. Fry, the remaining solo artistes are more or less familiar. Instrumental music will be in the ascendancy, and no doubt a very enjoyable concert will result. We may add that Major-General Webber has for the second time kindly consented to preside.

**Theatre Lighting.**—The theory of safety from fire in the electric lighting of theatres and other public places has received another check. On Saturday night, during the performance at the Comedia Theatre in Madrid, before a full house, an alarm of fire was raised, and almost immediately the theatre was in complete darkness. A panic of the worst kind appeared imminent; but, fortunately, some candles were quickly lighted, and the presence of mind of some portion of the audience sufficed to allay alarm. It was soon found that the fire was confined to part of the wings of the stage, and was of little importance, and the audience vacated the theatre quietly, without accident. The origin of the fire appears to have been the accidental connection of two imperfectly covered wires, causing them to emit sparks, which ignited some light canvas in the side scenes.

**Failure of Electric Light at Leeds.**—The *Leeds Mercury* complains about the lighting of the Town Hall. It says: "Somehow the dynamo gets lame in its supply. Two or three of the lamps catch the current and give forth a small solar blaze, but the others are as dark as the moon on the obscure side."

**The Paris-London Telephone.**—At Paris, the apparatus in connection with the Paris-London telephone will be provisionally installed at the Bourse. The telephone will be available night and day, and also on Sundays.

**London County Council.**—At the meeting of the London County Council on Tuesday last, Mr. Basset Hopkins drew attention to the fire at the Grosvenor Gallery, and asked whether the fire was caused, as he had heard, by the over-heating of an electric wire. If this gentleman, along with others, would cease to accept newspaper reports as reliable on technical subjects, there would be fewer lost sheep in this world.

**Execution by Electricity.**—The Supreme Court of the United States has approved the judgment of the Circuit Court in the case of Shibuya Judiro, a Japanese, confined in Sing Sing jail under sentence of death by electricity.

**City and South London Railway.**—A number of trains, each consisting of an electric locomotive and three carriages have been running regularly for some days on this railway, in order to educate the staff in the working of the electrical plant, the hydraulic lifts, and other matters which are peculiar to the undertaking. It is expected that the final inspection of the Board of Trade will take place within a few days, and that the line will then be open to the public. On Monday, the 24th inst., on the recommendation of the Prince of Wales, who recently inaugurated the completion of the undertaking, H.S.H. Prince Hermann of Saxe-Weimar privately visited the railway. He was accompanied by Major Cardew, representing the Board of Trade, and was met at the City Station by Mr. C. J. Mott, the chairman of the company; Mr. Greathead, the engineer; Mr. Jenkin, the general manager; and Mr. Basil Mott, resident engineer, and proceeded at once to the special train which was awaiting him at the King William Street terminus. There he was met by Mr. Wm. Mather, M.P., and Dr. Edward Hopkinson, and Mr. Grindle, the resident engineer of Messrs. Mather and Platt. The train rapidly made the journey to Stockwell, stopping at each of the immediate stations. At Stockwell, the boiler house, engine house, and carriage sheds were examined, and the electrical working was explained by Mr. Mather and Dr. E. Hopkinson. On the return journey the Prince expressed a desire to travel on the electrical locomotive, so as to more closely inspect its working. The Prince expressed himself as very much pleased and gratified with all he had seen.

**Electric Tramways Abroad.**—The recent failure of the accumulator system on the Sandhurst-Eaglehawk Electric Tramway, Australia, though it is no doubt a blow against the method of traction, does not appear to be such a complete condemnation as might appear at first sight. In the *Argus* for September 30th, it is stated that the batteries were guaranteed to give a speed of 8 miles an hour on a level road; but that, unfortunately, there were several steep gradients in the line, reaching as much as 1 foot in 20 feet, the result being that an average of about 6 miles an hour only could be attained. If the circumstances as reported are correct, it is not surprising that failure was the result; it is only a wonder that the cars were kept running for the 94 days that they did. To attempt to work such heavy gradients with the power at command was the height of folly. For the colonies, generally, there appears a splendid opening for electric traction, as the streets are wide, and, as a rule, nearly straight, and, moreover, the traffic is not congested. For some streets, however, there seems to be a great objection to the overhead system, whilst the channel system cannot be used, owing to frequent flooding; probably, however, in view of the advantages of the method of traction, overhead wires may, after all, be allowed.

**Electric Light in Barcelona.**—In a note of this subject on October 31st, we stated the *Los Anales de la Electricidad* looked unfavourably on a scheme of lighting at 10,000 volts. This voltage was a mistake, as the machines supplied by Woodhouse and Rawson United, Limited, are Ferranti machines, and only work at 2,400 volts. It is expected that the installation will be fitted up in about two months.

**Royal Naval Exhibition, 1891.**—Firms intending to exhibit objects connected with the Royal Navy or Maritime interests are reminded that all applications must be made by November 30th.

**Seeing by Electricity.**—Coining new words is seldom a successful pastime, and no matter how reasonable a suggestion may be, a host of objectors is sure to spring up who find fault, generally from "pure cussedness," if for no other reason. The use of the word "telephane" is, of course, at once objected to, but the objector in suggesting "telope" is certainly not right, as "ope" represents nothing connected with the subject. The nearest in that direction would be "teleopt," from *optikos*, i.e., pertaining to sight. "Telephane" is certainly euphonious, and its derivation from *phainein*, "to show," or *phaneros*, "visible," is etymologically correct.

**Electric Light in Birmingham.**—Two public companies, the Birmingham Electric Supply Company and the Birmingham House-to-House Electricity Company, have applied to the Board of Trade for provisional orders enabling them to supply electricity for public and private purposes in that city.

**A Storehouse of Knowledge.**—The November number of the Proceedings of the Physical Society contains a number of articles bearing on electricity, to wit:—"On a Carbon Deposit in a Blake Telephone Transmitter;" "The Villari Critical Points in Nickel and Iron;" "On the Shape of Movable Coils used in Electrical Measuring Instruments;" "Considerations on Permanent Magnetism;" "On the Results of Some Recent Magnetic Work;" "Galvanometers;" "On Huygens's Gearing in Illustration of the Induction of Electric Currents;" "On the Diurnal Variation of the Magnet at Kew;" "The Effect of Change of Temperature on the Villari Critical Point of Iron;" "Notes on Secondary Batteries."

**Tenders Wanted.**—Tenders are required for electric lighting plant and machinery for Pretoria, in the South African Republic. Particulars will be seen in our advertisement columns.

**Count Mattei Again.**—Under the heading of "People we Know," a weekly journal, which is claimed to have a certain status, holds forth as follows:—"Count Mattei, the famous Italian cancer curer, is now over two-and-eighty, but looks three decades younger, and, though he has lived for many years alone on the hills near Bologna, his manners are those of a polished man of the world. He says he owes his rugged health to the use of his famous electric globules, which he takes daily in his coffee, and which give the taker an imperceptible electric shock—the principle and secret that distinguish his medicines from homoeopathy. He tells many stories of miraculous cures he has effected by the aid of his "blue electricity," and says that he owes its discovery to a mangy dog, which every day ate at the same plant in the woods. Before that time he had cured people of nervous disorders by putting them into a completely violet room, which, he declares, is most soothing to the nerves. By trying a decoction of the plant used by the dog, he was able to cure skin diseases. His great secret lies in the fixing of electricity in these decoctions; this secret nobody knows, not even his adopted son, and when the medicines are thus far prepared by other hands, he puts the supreme and finishing touch himself." In the words of a financial contemporary, we may say, "Lord, how long?" How long will such statements be scattered broadcast to delude the ignorant, and how long will papers continue to advertise these absurdities?

After referring to the visit of Mr. Stead to Count Mattei, for the purpose of writing an article in the next issue of the *Review of Reviews*, regarding the latter's "secret electricity," the *Star* states that "the electricity is taken internally."

**New Cable Across the North Sea.**—A new cable was completed last week for the Great Northern Telegraph Company, between Newbiggin (near Newcastle) and Marstrand (Sweden). The cable was manufactured by the Telegraph Construction and Maintenance Company, and laid by that company's vessel, the *Seine*. The work seems to have been carried out with very creditable despatch. The total length of cable specified amounted, we believe, to about 550 nautical miles, and comprised the following types:—Shore end: Inner sheathing, 12 galvanised iron wires, each 0·170 inches diameter; outer sheathing, 14 galvanised iron wires, each 0·300 inches diameter. Total weight about 15 tons per N.M. Heavy intermediate: 12 galvanised iron wires, each 0·300 inches diameter. Total weight about 10·5 tons per N.M. Intermediate: 12 galvanised iron wires, each 0·200 inches diameter. Total weight about 5 tons per N.M. Deep sea, No. 1: 12 galvanised iron wires, each 0·170 inches diameter. Total weight about 3·75 tons per N.M. Deep sea, No. 2: 17 galvanised homo wires, each 0·099 inches diameter. Total weight about 2·5 tons per N.M. The core is composed of seven strands of copper, weighing 180 lbs. per N.M., and 180 lbs. of gutta-percha. The foregoing figures are necessarily only approximate, and we are unable to state the quantity of each particular type manufactured or laid.

**"A Coming Man."**—The *London Figaro* gives a short biographical sketch of Mr. Greathead, the engineer of the South London Railway, under its series of "Coming Men." Considering that Mr. Greathead is a man who "has come," it appears that the *Figaro* might have reserved its space for somebody less well-known.

**Telephonic Appointment.**—The newly-licensed Mutual Telephone Company has just concluded an arrangement with Mr. A. R. Bennett, whereby he becomes their general manager and chief engineer for three years. Mr. Bennett has retained power to practise as a consulting electrical engineer, and will have his headquarters in London. It will be remembered that Mr. Bennett resigned his post of divisional general manager in Scotland to the National Telephone Company last July in consequence of disagreements with the directors who insisted upon reverting to methods of construction which he had abandoned years before as obsolete.

**Applied Classics.**—The *Daily Telegraph* asks, Do electrical engineers, as a rule, know their Latin grammar? If not, the Postmaster-General's so-called epigram at the Criterion Restaurant on Thursday evening must have been "caviare to the general." If, however, there did lurk within their scientific brains any memory of an early and effete classical education, they must have found it somewhat difficult to reconcile Mr. Raikes's paraphrase with the original. The point of the Latin lines is that the three-fold goddess has three distinct offices with three different weapons in three divergent regions. As Proserpine she scares the shades below with her sceptre, as Luna she lights the upper air with her beams, as Diana she drives the wild beasts with her arrow. If the application must be transferred to the various uses of the electric light, it might run somewhat as follows: "The Underground she lights upon its way (or rather she ought to, if only the Metropolitan Railway Company were sufficiently civilised), or helps the high-throned 'gods' to see the play, or drives the 'Bears' on 'Change to find their prey."

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**House-to-House Electric Light Supply Company, Limited.**—At an extraordinary general meeting of the members of this company, held at the Central Electric

Lighting Station (Kensington), Richmond Road, S.W., on the 9th, it was resolved that £60,000 in 12,000 shares of £5 each, being part of the original capital, be issued as 7 per cent. cumulative preference shares, with a right of priority on any distribution of assets, and with the option of exchange of each preference for an ordinary share upon giving one month's notice. The resolution was confirmed on the 24th ult. and was registered 17th inst.

**Monte Video Telephone Company, Limited.**—The annual return of this company, made up to the 14th inst., was filed on the 17th inst. The nominal capital is £220,000 divided into 29,000 preference and 15,000 ordinary shares of £5 each. The shares taken up are 28,000 preference and 15,000 ordinary, 3,000 of each being considered as fully paid up. Upon 25,000 preference and 12,000 ordinary shares the full amount has been called, the calls paid amounting to £185,000.

**Northern Counties Electric Light and Power Company, Limited.**—The statutory return of this company, made up to the 9th inst., was filed on the 17th inst. The nominal capital is £1,000 in £1 shares, 100 of which are founders' shares; 7 founders' shares are taken up, upon which no call has been made. Office, 13, Victoria Street, S.W.

**Paddington and Bayswater Electric Light and Power Supply, Limited.**—The statutory return of this company, made up to the 9th inst., was filed on the 17th inst. The nominal capital is £1,000 in £1 shares, 100 of which are founders' shares; 7 founders' shares are taken up, but no call has been made thereon. Registered office, 13, Victoria Street, S.W.

**Electric and General Investment Company, Limited.**—The statutory return of this company, made up to the 30th September, was filed 10th ult. The nominal capital is £200,000, divided into 39,900 ordinary and 100 founders' shares of £5 each. The shares taken up are 10,000 founders' and 20,000 ordinary, and upon the former the full amount has been called, and upon the latter £1 per share has been called. The calls paid amount to £20,400, and unpaid to £100. Registered office, 1 and 2, Great Winchester Street.

**Yorkshire House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889, filed 20th inst., with the House-to-House Electric Light Supply Company, Limited, provides for the allotment to that company of 100 fully-paid founders' shares in this company, in consideration of the payment of the preliminary expenses. The first director nominated by the House-to-House Company is Mr. Robert Hammond, who is to be paid £100 per annum of the £500 per annum set aside for minimum directors' fees.

**Western House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889 (filed 20th inst.), with the House-to-House Electric Light Supply Company, Limited, provides for the allotment of 100 founders' shares to that company, in consideration of the payment of preliminary expenses. Mr. Robert Hammond is appointed a director, and is to receive £100 per annum of the £500 per annum set aside for minimum directors' fees.

**South of England House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889, and filed 20th inst., with the House-to-House Electric Light Supply Company, Limited, provides for the allotment of 100 founders' shares to that company, in consideration of the payment of the preliminary expenses of this company, and also appoints Mr. Robert Hammond a director, at a remuneration of £100 per annum out of the £500 per annum set aside for minimum directors' fees.

**Scottish House-to-House Electricity Company, Limited.**—An agreement of 24th June, filed 20th inst., with the House-to-House Electric Light Supply Company, Limited, is similar in terms to the agreements of the three preceding companies.

**Northern House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889, filed 20th inst., is similar in terms to the four preceding companies' agreements.

**Midland House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889, filed 20th inst., with the House-to-House Electric Light Supply Company, Limited, is similar in terms to that entered into by the five preceding companies.

**Manchester House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889 (filed 20th inst.), with the House-to-House Electric Light Supply Company, Limited, is similar in terms to the foregoing.

**Liverpool House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889, with the House-to-House Electric Supply Company, Limited, is similar in terms to the foregoing.

**Lancashire and Cheshire House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889 (filed 20th inst.), with the House-to-House Electric Light Supply Company, Limited, is similar in terms to the foregoing.

**Irish House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889 (filed 20th inst.), with the House-to-House Electric Light Supply Company, Limited, is similar in terms to the foregoing.

**Birmingham House-to-House Electricity Company, Limited.**—An agreement of 24th June, 1889 (filed 20th inst.), is similar in terms with the agreement entered into by the preceding companies.

## CITY NOTES, REPORTS, MEETINGS, &c.

### The Electric Construction Corporation, Limited.

THE directors' report to be submitted to the shareholders at the ordinary general meeting to be held at Worcester House, Walbrook, London, E.C., on Monday, the 8th day of December, 1890, at 12 o'clock noon, shows a profit of £52,639 3s. 2d. It further states that this may be considered as eminently satisfactory, having regard to the facts that (1) the corporation did not enter into full possession of all the properties acquired until October 31st, 1889; and (2) the corporation has not during the past year had the benefit of the increased power and economy of production to be derived from the new Bushbury Works, to which special reference is hereafter made.

From the profit of £52,639 3s. 2d., the board have written off the whole of the preliminary expenses of the formation of the corporation, amounting to £4,348 7s. 6d., and they have also carried to capital account a considerable sum resulting from licenses and re-sales of patents. No patents have been sold or licenses granted which can, in the opinion of the directors, prejudice the profit-earning power of the corporation, and possibly a certain portion of the amount so applied to capital might have been regarded as divisible profits; but, having regard to the large amount of the capital of the corporation at present represented by patent rights, the directors are satisfied that the shareholders will support the more prudent policy which has been adopted.

From the profit balance of £48,290 15s. 8d. the directors recommend:—1. That the sum of £15,000 be placed to reserve account against depreciation. 2. That a dividend of 6 per cent. be declared and paid upon the capital which has been from time to time called up, and paid in respect of the ordinary shares of the corporation, from the date of allotment on the 7th day of June, 1889, to the 30th day of September, 1890, inclusive, carrying forward the balance to the current year's account.

At an early date after acquisition of the Elwell-Parker business, the directors satisfied themselves that the existing Wolverhampton (Commercial Road) Works were inadequate to cope with the large and increasing orders for electrical goods, and particularly for those of the heavier class now in demand for central stations. A very advantageous site was secured at Bushbury, near Wolverhampton, immediately adjoining and in direct communication with the London and North Western Railway Company. Works have been there erected which, it is believed, will enable the corporation to supply electrical work of any class; but, having regard to the manner in which the business of the corporation has developed, provision has been made for still further extensions, should the necessity arise. The cost of the construction of these works with the necessary land, sidings and machinery, has, of necessity, been great; but the directors are satisfied that the capital of the corporation has been well expended.

In the prospectus of the corporation, it was stated that "as the business and profits of the corporation increase the directors will

from time to time propose the issue of additional capital, but care will be taken that the holders of the original capital shall be entitled to a preference or priority of allotment in subsequent issues." To secure the full advantage and profits of increasing business, it is desirable that a considerable addition should be made to the resources of the corporation. In the opinion of the directors a debenture issue would be more economical and advantageous to the present shareholders than an increase of capital either by ordinary or preference shares. Subject to any expression of opinion on the part of the shareholders at the general meeting, the directors therefore propose to make a sufficient debenture issue. Care will be taken that shareholders desiring to subscribe to these debentures shall have the opportunity of doing so.

In accordance with the articles of association, four of the directors, viz., Sir Daniel Cooper, with Messrs. Balfour, Courtenay and Dibley, retire from the board, all of whom are eligible, and offer themselves for re-election. The directors regret that the pressure of his professional engagements has compelled Sir Douglas Fox to resign his seat at the board. Sir Henry C. Mance, C.I.E., has consented to give the corporation the benefit of his great experience and scientific knowledge, as chairman of the board.

Messrs. Broads, Paterson & Co., the present auditors of the corporation, retire and offer themselves for re-election.

### Swan United Electric Light Company, Limited.

AN ordinary general meeting of the above company was held on Tuesday last at the Cannon Street Hotel, when the eighth annual report, which appeared in our last issue, was presented, and a balance of 10 per cent. for the year was declared.

The Chairman (Mr. J. S. Forbes), in the course of his remarks, said: The share capital of the company amounted to £375,000. Of this, £3,531 had been paid by people who had omitted to pay up their calls, and was consequently forfeited to the company. The cost of patent rights, &c., represented by shares in the Edison and Swan United Electric Light Company, was £208,478; shares in La Compagnie Générale des Lampes Incandescentes amounted to £30,489, and over and above those two solid assets there were patents held by the company for Germany, and other sources of income which were open to them as possessors of patent rights in England and abroad—outside of Europe. The absorption of the British business of the company by the Edison and Swan Company had been a very happy investment for them, as the bulk of the dividend which it was proposed to divide that day had come to them in respect of shares held in the Edison and Swan Company. Referring to the French Company, they had been in litigation with a powerful body of people in France—and France meant Russia, Austria, and other countries as well—for the Edison and Swan Company were doing in France what they had been doing in London, litigating the patents. They had thought it wise to avoid litigation among themselves and come to terms. A company was formed, a certain amount of money was subscribed by the two companies, and each was credited with a further sum in the nature of a goodwill. Out of Europe they had all the world—with some exceptions—which they could supply with lamps if they could find the customers. Referring to profit and loss, among other items was £26,733 due from sundry debtors, a large sum of money, but about £23,000 of it was dividend payable by the Edison Company to themselves. The older shareholders would remember that for some years no dividend had been paid, and, what was worse, the balance at the end of the year had been against the undertaking: they had determined as a matter of prudence to write down out of the profits of the following years all losses realised in the earlier years of the company. Their first balance to the good had been in 1887, in the following year they had had a further credit balance, but the proprietors had concurred with the directors in recommending that both amounts should be held in hand, and it was in 1889 that for the first time in the history of the company a dividend was distributed. The sums thus saved figured now in the balance sheet. The total outlay upon patent rights amounted now to £330,837 2s. 5d. They had been writing down their stock and plant very liberally for a number of years. They had an investment in the Prussian Consols, which the German Government had required them to deposit as a sort of caution money, and £29,004 19s. 6d. invested in the 2½ per cents. Cash on deposit and in hand amounted to £10,669 16s. Referring again to the item of stock, they had thought it prudent to write down stock approximately to the manufacturing price, because something might arise which would prevent the sale of a large stock of lamps at a much higher one, and lamps were put down at 10d. each which if sold for even so low a price as 1s. 6d. would leave a very large profit. Office expenses, &c., amounted to £3,513, and wages and expenses at factory to £5,000. On the other side of the account they would see among other figures the dividend on the shares in the Edison and Swan, £30,665 13s. 8d., which was quite 8 per cent. on the money invested with them. Those who had taken sufficient interest in the company, attended its meetings, and read its reports, knew that its future was likely to be fairly prosperous. They had protection for a certain number of years, but their policy was not founded upon protection. They hoped at the end of the protected period to have such a capacity, and such a clientèle that nobody should be able to work against them; but so long as protection lasted the dividend from the Edison and Swan Company might be looked for as a considerable one. The French

company had only just started, but already they had a very fine factory, though they had not succeeded so well as the English company in producing an efficient and economical lamp. It took a long time to get into the best groove, but they had all the advantage of the experience gained by the English company. Another difficulty of the French company was that they were still in litigation, and that a number of people took advantage of the fact to infringe their patents. Until the litigation was settled, too, they did not know the value of their business there. In Germany they were engaged in litigation with the Edison Company, and until the decision of the Supreme Court at Leipzig, to which they had appealed, was given, they would not know whether they had a right to make and sell their lamps in that country or not. The Chairman concluded by moving the adoption of the report, which was carried.

A few remarks by Mr. F. J. Mills were replied to by the Chairman, and the two retiring directors (Mr. F. R. Leyland and Mr. W. C. Quilter) were re-elected. The usual vote of thanks concluded the meeting.

### The Montevidean and Brazilian Telegraph Company, Limited.

AN extraordinary general meeting of this company was held at Langthorn House, on Tuesday, to receive special resolutions as to the winding up of the companies, and to consider an agreement made with the Western and Brazilian Telegraph Company for taking over the whole undertaking. The solicitor, having read the agreement,

The Chairman, in explaining the state of affairs, dwelt with satisfaction on the good bargain which he considered had been made. If anyone was inclined to cavil at the results of the working of the company, he would remind them that the present directors were not responsible, as when they came into office 15 or 16 years ago the affairs were in a very bad way. The first duty was to rescue the company from bankruptcy, and the secretary and himself had to assist the company by advancing a considerable sum of money to tide over difficulties. They had never been able to develop the resources of the company, because agreements with the Platino Company and the Western Brazilian Company bound them hand and foot. The speaker then referred to the agreement of 1885, which was drawn out, but was not finally accepted for some reason or other by the Western Company. Had this taken place at that time the property would have been secured on much better terms. On account of their own shares being now more valuable, a highly favourable arrangement had been made.

After further remarks the following resolutions were adopted:—

1. That the company be wound up voluntarily under the provisions of the Companies' Acts.
2. That George Fraser, F.C.A., be and he is hereby appointed the liquidator to conduct such winding-up.
3. That the agreement submitted to this meeting, dated 3rd November, 1890, and expressed to be made between this company of the one part, and the Western and Brazilian Telegraph Company, Limited, of the other part (being an agreement for the sale and transfer to the Western Company of the whole of this company's undertaking) be and the same is hereby approved. And that the liquidator be, and he is hereby authorised, in pursuance of Section 161 of the Companies' Act, 1862, and of all other powers enabling him in that behalf to carry said agreement into effect with such modifications (if any) as he may think expedient.
4. That the liquidator be and he is hereby authorised to receive, and when received to distribute amongst the holders of preferred shares in this company, the rent accruing to this company from the Western and Brazilian Telegraph Company, Limited, for the year ending 31st December, 1890.

A meeting to confirm the foregoing resolutions will be held in a fortnight's time.

### Blackpool Electric Tramway Company, Limited.

#### ANNUAL MEETING OF SHAREHOLDERS.

THE sixth ordinary general meeting of the members of the Blackpool Electric Tramway Company, Limited, was held at the Victoria Schools, Tyldesley Road, Blackpool, last Saturday afternoon. Mr. Alderman Richard Horsfall, J.P., C.E., F.S.I. (Halifax), chairman of directors, presided, and the following directors were present:—The Mayor of Blackpool (Mr. Alderman J. Bickerstaffe); Mr. T. H. Morris, J.P. (the Lodge, near Halifax), Vice-Chairman; Mr. J. Broadbent (Manager), Blackpool; Mr. G. H. Smith, Park House, Halifax; Mr. John Oddie, Halifax; Mr. Theodore Ormerod, Elm Royd, Brighouse, directors.

After the report had been read (an abstract of which appeared in the REVIEW last week),

The Chairman said it was his pleasure to meet them again as chairman of the Blackpool Electric Tramway Company, and to congratulate them, he thought, upon their balance-sheet. He did not know that he could say anything to them that day, excepting perhaps that they were working satisfactorily, all the machinery was in good working order, their furnaces were good, and that the directors felt that they came before the shareholders with a thoroughly sound and honest balance-sheet. (Hear, hear.) He had great pleasure in proposing the adoption of the report and balance-sheet as presented.

Mr. MORRIS (Vice-Chairman), in seconding the resolution, concurred in the remarks of the chairman. All their plant and property was in first-class order, while the prospects of the company, so far as they were able to judge, were never more satisfactory than at the present time. The dividend had been honestly and satisfactorily earned, and the amount put away for depreciation was felt to be needed for contingencies that might arise in the future.

The resolution was carried unanimously.

ELECTION OF DIRECTORS.—SOMETHING LESS THAN A COMPLIMENT.—AN OUTSPOKEN SHAREHOLDER.

Mr. Barcroft moved that the retiring directors, Messrs. Ormerod, Shaw and Smith be re-elected.

Mr. Hoyle: Does Mr. Holroyd Smith (patentee) ever attend?

Mr. G. H. Smith: I am his brother; he is not on the directorate.

Mr. Hoyle: Oh, that alters the case. I was going to ask him a question or two, for a more one-sided bargain, from first to last, I never came across than the one made by this company with the Blackpool Corporation. It is so bad in fact, that I consider it a positive disgrace, and I am ashamed to tell anybody about it. (Laughter.) It was the most one-sided business he had known "since he were created." (Loud laughter.) Was there any need to re-elect the three retiring directors? He had been at meetings where he had heard of the directors of that company say that five directors were ample. He believed they could be too many.

Acting on a suggestion here, the attendances of the directors were read.

The Chairman said the meetings varied according to the season. He came down frequently, and if he thought it necessary to hold a meeting, one was called. There were no fixed dates for meetings. In answer to a question, the Chairman said they had two resident directors. Formerly they had three, but Dr. Kingsbury had sold out his shares.

Mr. Hoyle said he might say that he had so much confidence in the manager, that he believed if the directors never came but once a year that they would not be any worse off. (Laughter.) It was more a matter of form having them as directors than anything else, in his opinion. (Renewed laughter.) Only they were a large number; whether they were all electricians or not he could not tell. No doubt all the shareholders would have been charged with something of the sort had there been no dividend for them. (Laughter.) He, however, had no objection to seconding the re-election of the three retiring directors. (Hear, hear.) Was it necessary to take the three together?

The Chairman: You require to give seven days' notice before proposing a new director, according to the rules.

Mr. Hoyle: Are there articles of association?

The Chairman: Yes.

Mr. Hoyle: I would be glad to have one and pay for it.

It was agreed to supply them to all shareholders at 1s. each copy.

Mr. Hoyle: I understand that at the end of seven years this concern can be taken from us by the corporation?

The Chairman: The corporation can give us notice during the last term of the first seven years. On the other hand, if they do not take that course, we shall have to give them notice that we wish to continue in possession. Then the same routine is gone through at the end of 14 years, and then if we keep it for 21 years, we shall reach the expiration of the agreement. This fact accounts for the large sum put to depreciation—we are compelled to provide for the worst contingency.

Mr. Hoyle: If it is a good thing they can take it?

The Chairman: Yes.

Mr. Hoyle: Then you may rely upon it they will take it. Blackpool people know a good thing when they see it, you may depend on that, and anything they can lay their hands on they will not let go past them. I have not much confidence in Blackpool people, I can tell you. I know them. (Laughter.)

The Chairman: If they take it they will have to pay for it.

Mr. Commissioner Buckley: Those who have got shares at a premium are likely to lose money by such an arrangement.

The Chairman: Well, I suppose they bought the shares for the dividends, and 7½ per cent. capitalised will make up the difference. Any shareholder who wishes to see the agreement between this company and the Corporation can do so only with the consent of the directors. This precautionary measure was necessary in the interests of the company.

The resolution was carried.

#### ELECTION OF AUDITORS.

Messrs. J. D. Taylor & Co., of Halifax, were reappointed auditors to the company, on the motion of Mr. Hoyle, seconded by Mr. Barcroft.

After further remarks and a vote of thanks to the directors, the meeting terminated.

#### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 21st, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,421.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ending November 21st were £6,637.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (November 20.)	Closing Quotation. (November 27.)	Business done during week ending November 27, 1890.
					Highest. Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	97 — 100	98 — 101	99 <sup>3</sup> / <sub>4</sub> ...
1,381,380	Anglo-American Telegraph, Limited	Stock	48 — 49	48 <sup>1</sup> / <sub>2</sub> — 49 <sup>1</sup> / <sub>2</sub>	49 <sup>1</sup> / <sub>2</sub> 48 <sup>1</sup> / <sub>2</sub>
2,809,310	Do. do. 6 p. c. Preferred ...	Stock	84 — 85	85 — 86 <sup>1</sup> / <sub>2</sub>	85 <sup>3</sup> / <sub>4</sub> 84 <sup>3</sup> / <sub>4</sub>
2,809,310	Do. do. Deferred ...	Stock	12 <sup>3</sup> / <sub>4</sub> — 13 <sup>1</sup> / <sub>4</sub>	13 <sup>1</sup> / <sub>4</sub> — 13 <sup>3</sup> / <sub>4</sub>	13 <sup>3</sup> / <sub>4</sub> 13
130,000	Brazilian Submarine Telegraph, Limited	10	10 <sup>3</sup> / <sub>4</sub> — 11 <sup>1</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>4</sub> — 11 <sup>3</sup> / <sub>4</sub>	11 <sup>3</sup> / <sub>4</sub> 11
84,500	Do. do. 5 p. c. Bonds...	100	101 — 103	101 — 103	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 — 108	104 — 108	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416...	3	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	1 — 1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub> ...
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1 <sup>1</sup> / <sub>2</sub> — 2	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	...
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104	103 <sup>1</sup> / <sub>2</sub> 102
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	...
16,000	Cuba Telegraph, Limited	10	11 <sup>1</sup> / <sub>2</sub> — 12	11 <sup>1</sup> / <sub>2</sub> — 12	11 <sup>3</sup> / <sub>4</sub> 11 <sup>1</sup> / <sub>2</sub>
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	17 <sup>3</sup> / <sub>4</sub> 17 <sup>1</sup> / <sub>2</sub>
12,931	Direct Spanish Telegraph, Limited	5	3 <sup>3</sup> / <sub>4</sub> — 4 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>4</sub> — 4 <sup>1</sup> / <sub>2</sub>	...
6,000	Do. do. 10 p. c. Preference	5	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	...
60,710	Direct United States Cable, Limited, 1877	20	9 <sup>1</sup> / <sub>2</sub> — 10 <sup>1</sup> / <sub>2</sub>	10 — 10 <sup>1</sup> / <sub>2</sub>	10 <sup>1</sup> / <sub>2</sub> 10 <sup>1</sup> / <sub>2</sub>
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13 <sup>3</sup> / <sub>4</sub> — 13 <sup>3</sup> / <sub>4</sub>	13 <sup>3</sup> / <sub>4</sub> — 14 <sup>1</sup> / <sub>2</sub>	14 13 <sup>3</sup> / <sub>4</sub>
70,000	Do. 6 p. c. Preference	10	14 <sup>1</sup> / <sub>2</sub> — 15 <sup>1</sup> / <sub>2</sub>	14 <sup>1</sup> / <sub>2</sub> — 15	14 <sup>1</sup> / <sub>2</sub> 14
200,000	Do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	105 <sup>1</sup> / <sub>2</sub> ...
1,200,000	Do. 4 p. c. Mortgage Debenture Stock	Stock	103 — 106	103 — 106	105 <sup>1</sup> / <sub>2</sub> 104 <sup>1</sup> / <sub>2</sub>
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13 <sup>3</sup> / <sub>4</sub> — 14	13 <sup>3</sup> / <sub>4</sub> — 14	14 13 <sup>3</sup> / <sub>4</sub>
320,000	Do. 6 p. c. Debentures, repay. February, 1891	100	100 — 102	100 — 102	...
91,800	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326	100	102 — 105	102 — 105	101 <sup>1</sup> / <sub>2</sub> ...
325,200	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400	100	102 — 105	102 — 105	101 <sup>1</sup> / <sub>2</sub> 103 <sup>1</sup> / <sub>2</sub>
145,300	Eastern and South African Tel. Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 — 104	101 — 104	...
198,200	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 — 104	101 — 104	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	8 — 8 <sup>1</sup> / <sub>2</sub>	7 <sup>3</sup> / <sub>4</sub> — 8 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> ...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>2</sub>	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>2</sub>	...
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 1 to 70,000	2	3 <sup>3</sup> / <sub>4</sub> — 4 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>4</sub> — 4	4 <sup>1</sup> / <sub>2</sub> 3 <sup>1</sup> / <sub>2</sub>
67,385	Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid	2	1 <sup>1</sup> / <sub>2</sub> — 2 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub> — 2 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> ...
20,000	Fowler-Waring Cables, Nos. 301 to 20,000 (£4 only paid)	5	2 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>2</sub>	...
180,227	Globe Telegraph and Trust, Limited	10	9 — 8 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> 8 <sup>1</sup> / <sub>2</sub>
180,042	Do. do. 6 p. c. Preference	10	14 <sup>1</sup> / <sub>2</sub> — 14 <sup>1</sup> / <sub>2</sub>	14 <sup>1</sup> / <sub>2</sub> — 15	14 <sup>1</sup> / <sub>2</sub> 14 <sup>1</sup> / <sub>2</sub>
150,000	Great Northern Tel. Company of Copenhagen	10	15 <sup>1</sup> / <sub>2</sub> — 16 <sup>1</sup> / <sub>2</sub>	15 <sup>1</sup> / <sub>2</sub> — 16 <sup>1</sup> / <sub>2</sub>	16 <sup>1</sup> / <sub>2</sub> 15 <sup>1</sup> / <sub>2</sub>
15,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104	...
230,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107	106 104 <sup>1</sup> / <sub>2</sub>
9,884	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	12 11 <sup>1</sup> / <sub>2</sub>
5,334	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	...
41,800	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 — 19	18 — 19	18 <sup>3</sup> / <sub>4</sub> ...
200,000	Do. do. 4 <sup>1</sup> / <sub>2</sub> p. c. Deb., 1896...	100	100 — 102	100 — 102	...
17,000	Indo-European Telegraph, Limited...	25	35 — 37	35 — 37	36 <sup>1</sup> / <sub>2</sub> 36 <sup>1</sup> / <sub>2</sub>
11,334	International Okonite, Ltd, Ordinary Nos. 22,667 to 34,000 (£7 pd.)	10	6 <sup>1</sup> / <sub>2</sub> — 7	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	...
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	6 <sup>1</sup> / <sub>2</sub> — 7	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...
100,000	Do. do. do. 6 p. c. Debentures	100	105 — 108	105 — 108	...
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 £8 pd.	10	6 <sup>1</sup> / <sub>2</sub> — 6 <sup>3</sup> / <sub>4</sub>	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	6 <sup>3</sup> / <sub>4</sub> 6 <sup>1</sup> / <sub>2</sub>
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub> 4 <sup>1</sup> / <sub>2</sub>
15,000	Do. 6 p. c. Cum. 1st Preference	10	12 <sup>1</sup> / <sub>2</sub> — 12 <sup>3</sup> / <sub>4</sub>	12 <sup>1</sup> / <sub>2</sub> — 12 <sup>3</sup> / <sub>4</sub>	12 <sup>3</sup> / <sub>4</sub> ...
15,000	Do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9 <sup>1</sup> / <sub>2</sub> — 10 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>2</sub> — 10 <sup>1</sup> / <sub>2</sub>	10 ...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8 <sup>1</sup> / <sub>2</sub> — 8 <sup>3</sup> / <sub>4</sub>	8 <sup>1</sup> / <sub>2</sub> — 9	8 <sup>1</sup> / <sub>2</sub> 8 <sup>1</sup> / <sub>2</sub>
9,000	Reuter's, Limited	8	8 <sup>1</sup> / <sub>2</sub> — 8 <sup>3</sup> / <sub>4</sub>	8 <sup>1</sup> / <sub>2</sub> — 9	8 <sup>1</sup> / <sub>2</sub> 8 <sup>1</sup> / <sub>2</sub>
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	2 <sup>1</sup> / <sub>2</sub> — 3	2 <sup>1</sup> / <sub>2</sub> — 3	...
3,381	Submarine Cables Trust	Cert.	113 — 117	113 — 117	...
78,949	Swan United Electric Light, Limited (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	5 — 5 <sup>1</sup> / <sub>2</sub>	4 <sup>1</sup> / <sub>2</sub> — 5 xd	4 <sup>1</sup> / <sub>2</sub> 4 <sup>1</sup> / <sub>2</sub>
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	44 <sup>1</sup> / <sub>2</sub> 43 <sup>1</sup> / <sub>2</sub>
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102	100 <sup>1</sup> / <sub>2</sub> ..
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...
146,128	Do. do. 5 p. c. Debenture Stock...	Stock	90 — 95	90 — 94	...
3,200	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...	...
15,809	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	...
290,900	Do. do. 5 p. c. Debentures	100	98 — 101	98 — 101	...
30,000	West Coast of America Telegraph, Limited	10	4 — 5	4 — 5	...
150,000	Do. do. 8 p. c. Debs, repay. 1902	100	102 — 107	102 — 107	...
64,174	Western and Brazilian Telegraph, Limited	15	10 <sup>1</sup> / <sub>2</sub> — 11	10 <sup>1</sup> / <sub>2</sub> — 11 xd	11 <sup>1</sup> / <sub>2</sub> 10 <sup>1</sup> / <sub>2</sub>
27,873	Do. do. 5 p. c. Cum. Preferred	7 <sup>1</sup> / <sub>2</sub>	6 <sup>1</sup> / <sub>2</sub> — 6 <sup>3</sup> / <sub>4</sub>	6 <sup>1</sup> / <sub>2</sub> — 6 <sup>3</sup> / <sub>4</sub> xd	6 <sup>3</sup> / <sub>4</sub> 6
27,873	Do. do. 5 p. c. Deferred	7 <sup>1</sup> / <sub>2</sub>	4 <sup>1</sup> / <sub>2</sub> — 5	4 <sup>1</sup> / <sub>2</sub> — 5	4 <sup>1</sup> / <sub>2</sub> ...
200,000	Do. do. 6 p. c. Debentures "A," 1910...	100	103 — 106	103 — 106	...
250,000	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106	...
88,321	West India and Panama Telegraph, Limited	10	3 — 3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>2</sub>	3 <sup>1</sup> / <sub>2</sub> 2 <sup>1</sup> / <sub>2</sub>
34,563	Do. do. 6 p. c. 1st Preference	10	11 <sup>1</sup> / <sub>2</sub> — 11 <sup>3</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>2</sub> — 11 <sup>3</sup> / <sub>4</sub>	...
4,669	Do. do. 6 p. c. 2nd Preference	10	11 — 12	11 — 12	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125	...
175,100	Do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103	100 <sup>1</sup> / <sub>2</sub> 100 <sup>1</sup> / <sub>2</sub>
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2 <sup>1</sup> / <sub>2</sub> — 3	2 <sup>1</sup> / <sub>2</sub> — 2 <sup>3</sup> / <sub>4</sub>	...

\* Subject to Founders Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6<sup>1</sup>/<sub>2</sub> paid), 7<sup>1</sup>/<sub>2</sub>—7<sup>3</sup>/<sub>4</sub>.—Elmore Copper Depositing Priorities, 7—7<sup>1</sup>/<sub>2</sub>.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2—2<sup>1</sup>/<sub>2</sub>.—House-to-House Company (£5 paid), 4<sup>1</sup>/<sub>2</sub>—5<sup>1</sup>/<sub>2</sub>.—London Electric Supply Corporation, Ordinary (£5 paid), 1<sup>1</sup>/<sub>2</sub>—2<sup>1</sup>/<sub>2</sub>.—Manchester Edison and Swan Company, £9 (£1 paid) 11/- —13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2<sup>1</sup>/<sub>2</sub>—3<sup>1</sup>/<sub>2</sub>.—Preference, 4<sup>1</sup>/<sub>2</sub>—4<sup>3</sup>/<sub>4</sub>.

## ITALIAN TELEGRAPH STATISTICS.

The following statistics are compiled from a recent official return regarding the position of telegraphy in Italy from July, 1888, to June, 1889:—

<i>Telegraph Lines.</i>		
Length in miles	...	21,647
Length exclusively for railway service	...	1,424
Mileage of wires	...	61,455
Mileage of wires for railway use	...	19,279

<i>Telegraph Offices.</i>		
State offices	...	2,437
Railway and private offices	...	1,369
Various	...	40

<i>Telegraph Apparatus.</i>		
Morse type	...	3,789
Hughes "	...	101
Various "	...	63

<i>Personnel.</i>		
Central office	...	213
Other offices	...	7,036

<i>Home Telegrams.</i>		
Subject to taxes	...	6,364,212
Despatched by the railways	...	713,797
Exempt from taxes	...	583,246

<i>International Telegrams.</i>		
Sent abroad	...	646,980
Received from abroad	...	773,829
" in transit	...	131,482
Service messages	...	216,860

<i>Receipts.</i>		
Home messages	...	£409,374
Foreign "	...	147,328
Various "	...	32,987

<i>Expenses.</i>		
Extraordinary: new offices, &c.	...	£23,979
Ordinary staff expenses	...	345,682
Maintenance, &c....	...	166,133

DINNER OF THE INSTITUTION OF  
ELECTRICAL ENGINEERS.

The second annual dinner of the Institution of Electrical Engineers was held last Thursday evening at the Criterion Restaurant, Dr. John Hopkinson, F.R.S., President, in the chair. About 200 gentlemen sat down to table, and among them were:—The Right Hon. H. C. Raikes, M.P. (Postmaster-General); Mr. Latimer Clark, F.R.S. (past president); Sir E. E. Webster, Q.C., M.P. (Attorney-General); Prof. G. Carey Foster, F.R.S. (past president); Mr. G. Berkley (vice-president Institution of Civil Engineers); Prof. W. Grylls Adams, F.R.S. (past president); Mr. W. H. M. Christie, F.R.S. (Astronomer-Royal); Mr. Edward Graves (past president); Prof. J. J. Thomson, F.R.S.; Sir Douglas Galton, K.C.B., F.R.S., D.C.L.; Major F. A. Marindin, R.E. (Inspector of Railways, Board of Trade); Major P. Cardew, R.E.; Sir Albert Cappel, K.C.I.E.; Sir Henry Mance, C.I.E.; Mr. Gisbert Kapp; Sir George Gabriel Stokes, M.P. (President Royal Society); Mr. W. H. Preece, F.R.S. (past president); Mr. J. Tomlinson, jun. (President Institution of Mechanical Engineers); Major-General Webber, C.B. (past president); Sir R. Rawlinson, K.C.B. (Vice-President Institution of Civil Engineers); Mr. C. E. Spagnoletti (past president); Prof. Dr. Coleman Sellars (member of the International Niagara Commission); Prof. D. E. Hughes, F.R.S. (past president); Sir Stevenson Arthur Blackwood, K.C.B. (Secretary General Post Office); Sir David Salomons (member of council); Captain W. J. L. Wharton, R.N., F.R.S. (hydrographer to the Admiralty); Sir James N. Douglass, F.R.S. (member of council); Sir James Anderson (member of council); Sir H. Trueman Wood (Secretary Society of Arts); Prof. S. P. Thompson, B.A., D.Sc. (member of council); Colonel B. Raynsford Jackson (member of council); Captain Stiffe; Mr. R. E. Crompton (vice-president); Herr Fritsche; Dr. Fleming; Mr. J. W. Swan; Mr. Bidwell, F.R.S.; Staff-Commander E. W. Creak, R.N.; Mr. W. Crookes (vice-president); Mr. J. C. Lamb, C.M.G.; Major-General Stotherd, C.B., R.E.; Prof. George Forbes, F.R.S.; Prof. W. E. Ayton, F.R.S. (vice-president); Prof. W. C. Unwin, F.R.S.; Mr. Gordon; Mr. Alexander Siemens (vice-president); Mr. F. H. Webb (secretary); and Mr. F. H. Webb, jun.

The PRESIDENT, in proposing the "Army and Navy," said he could have wished that this toast had been consigned to abler hands, but the committee who had arranged the toasts had insisted

that it was the duty of the President to propose the major portion of them, and he had to give way. If there was any one profession to which electrical engineers were indebted more than to any other it was the profession of arms. The telegraph was the nervous system of the army in the field, the application of electricity to explosions and to submarine minings was a necessity, and the largest arc lights, as they knew, were those which were employed observing the approach of hostile torpedoes; while, further, if the nation were not ready to repel aggression by force of arms, the enormous system of submarine telegraphs could hardly exist. He coupled with the toast the name of General Stotherd, who, as they knew, paid considerable attention to field telegraphs, and who was also head of the ordnance survey. With the toast of the navy he coupled the name of his friend, Captain Wharton, who was best known in connection with the more peaceful functions of the navy.

General STOTHERD spoke of the enormous sums of money spent in order to bring the army and navy to that state of efficiency which has been necessary of late years. When he was at Chatham, nearly 20 years ago, he had the pleasure of organising the field telegraphs, also the system of submarine mines, which had since been adopted. The gallant gentleman referred to the extensive use of the telegraph in the last Russian campaign, and averred that in the wars in the Soudan and South Africa the extensive operations could not have been carried out without it. While speaking of the electric telegraph, he drew attention to the extensive reserve in connection with field telegraphy in the Post Office. By means of that reserve they had been able recently to enter upon—and without difficulty to carry on—operations simultaneously in the Soudan and in South Africa. With regard to submarine mines, they had not yet, he was glad to say, had any opportunity of trying what they could do in war, and, indeed, he sincerely hoped they would never have to use them. Many people were averse to them because they thought merchant vessels would be prevented coming into port; but he entirely disagreed with them. The system was so arranged that there would be no difficulty whatever.

Mr. RAIKES, in returning thanks, said: Mr. President and Gentlemen, it is, I am aware, no small honour to return thanks for the toast of Her Majesty's Ministers in such a company and on such an occasion. And yet I feel some little diffidence in addressing myself to the task when I remember that it has been previously performed by no less a person than the head of the present Government, the Marquis of Salisbury, and he is not only the head of the Government, but he is, what I cannot pretend to be, a somewhat expert electrician. I have also near me another friend of mine, who likewise belongs to her Majesty's Government, the Attorney-General, who is known to many gentlemen here not less as an electrical expert than as a profound lawyer; and on one very important occasion, when I had recourse to his advice, I found that, in my opinion, his electricity was as good as his law. (Laughter.) At all events, his electrical skill enabled us to steer out of a difficulty which otherwise might have required us to apply to his law. (Laughter.) It is no doubt a fact that the department which I am called on to preside over has closer relations with electrical engineering than perhaps any other of the great departments of the State. It is not necessary that I should refer in detail to the enormous amount of telegraphic business which has grown up in the 19 years during which the department of the Post Office has been charged with its administration in this country. But it is probably interesting to know that in that time the number of telegrams has grown from 10,000,000 in 1871 to 62,500,000 in 1889 that is to say, it has sextupled in the course of those 18 years. You will easily understand how important it is for our department to be *au courant* with all the latest developments of electrical science and the wonders of electrical skill. It is not without feelings of pride that I recall the fact that the Post Office has given to this institution three of its presidents—Mr. Scudamore, Mr. Preece, and Mr. Graves—for all of them occupied the chair which you, Mr. President, now fill; and I am happy to think that they have been able to render great service to the science of electricity at the same time that they have not thereby been induced in the smallest degree to neglect their public duty to the department which they so efficiently served. But it is not the Post Office alone of Government departments which has relations with electrical engineering. Second to the Post Office, if indeed second, is the Board of Trade in relation to your science. The Board of Trade has special charge of lighthouses, and the Board of Trade has had the opportunity of testing and of specially utilising more than one of the considerable discoveries of your president in that branch of electric science. We can only regret that in the neighbouring country of Spain, on whose shores that terrible catastrophe happened the other day, there is not, as far as I am aware, either a Board of Trade or an Institution of Electrical Engineers. If they had the advantages which we possess, we might hope and believe that the lights at Cape Villano might have been in such a state as to prevent the loss of that good ship and of those brave lives that went down into the deep. The Board of Trade is not only interested in lighthouses, but also in the great question of electric lighting. I know that a great many gentlemen, and perhaps a majority of those present, are of opinion that electric lighting has been unduly arrested by the jealousy of Parliament, or of departments of the Government. I understand that feeling, but I do not share it. When you have a young science, it is desirable to give that science time to feel its feet, and in some way appreciate what it can do before you rush headlong into employing it. I cannot but think that Parliament has been wise in holding

its hand for some years before taking any decisive steps for licensing and extending the use of the electric light, because it has no doubt given time for experiments to greatly improve the science, and to secure for the public, now that they are beginning to make use of it, a very much better article in the way of electric light than they would have done had they rushed blindly into it eight or ten years ago. The Board of Trade has another connection with electrical engineering—with respect to electricity as a motive force. The recent opening of the new subterranean railway in South London has given us all an opportunity of testing, by actual experience, how this most interesting experiment will work, and it will be the special duty of the Board of Trade to keep its eyes open, to study the working of the new system, and report upon it in an independent way, which will enable the public generally to judge for themselves how far that experiment may be imitated elsewhere. Then the Admiralty has its relations with electrical engineering, because day by day it is becoming more and more necessary to have recourse to electricity in handling those great monsters of the deep, which are the fighting ships of our day, and are so ponderous and unwieldy, that ordinary skill might be powerless to handle them. The War Office, too, as you know, is also dependent on electrical engineering, for no man nowadays could take the field for a campaign unless he had obtained the best means for the supply of information, both from the front to headquarters and from headquarters to the front. Therefore you see all those departments of the State are separately very much beholden to the electrical engineers. It is on behalf of them all that I address you this evening and tender to you the grateful thanks of her Majesty's Ministers for the great services you have rendered to them. It is almost impossible, in dealing with the operations of a body like this, to over-estimate the enormous changes which through your instrumentality are affecting our daily life. I am not going to say, as I believe some enthusiasts say, that you have actually annihilated time and space, but you have so far modified time and space that it is impossible for those who live in this day to attach to those words anything like the sense in which they were used in the preceding generation. You are perpetually finding out new fields. It is not merely that you have covered all these grounds, but you are making for yourselves a great field in manufactures; and even in the healing art electricity is coming to play a very important part. Not only may a man be taken to his business in the morning by electricity, not only may he see his manufactory conducted by electricity, but he may have the advantage of having his tooth taken out by electricity if he has any weakness of that kind. It is impossible to forecast the enormous future before this particular branch of science. You seem to have taken to yourselves the attributes of the whole of that Pantheon, the whole of those influences which in ancient days were supposed to dominate our sublunary life. But if I had to single out among those mythological deities any one which might seem more appropriately to be the patron or patroness of your science, I would say that you seem to me to have borrowed in a special degree the attributes of that goddess who, we remember—probably those of us who still retain the rudimentary features of our school training—adopted a threefold name and a threefold aspect. If you will permit me, I will conclude with those two lines with which our Latin grammar has made us familiar:—

"Terret, lustrat, agit Proserpina, Luna, Diana,  
Ima, suprema, feras, sceptrum, fulgore, sagittâ."

As I was coming down here I thought I might perhaps venture to string together this little paraphrase of those lines:—

"Our threefold goddess, with her magic spells,  
By turns alarms, enlightens, and impels,  
While hangs the pale exchange upon her strings,  
Her lamp cheers cities, and her touch gives wings."

Mr. LATIMER CLARK, Past-President, in proposing "The Learned Societies," said it was unnecessary for him, in a meeting such as this, to give any commendation or recommendation to that toast. They knew perfectly well what the learned societies had done for them and for science; they knew they had given lustre to the times in which they lived. They had to a large extent, perhaps, created benefits to the electrical engineers greater than to any other body of men. They—the electrical engineers—had received from those societies, to a very large extent, the laws which enabled them to know the behaviour of that singular agent, or fluid, or force with which they had to deal. But the learned societies had a yet higher claim upon their respect and admiration. The learned societies of this and other countries had been able to pursue not only the love of science and the desire to gain knowledge, they had also been able to attain, or to endeavour to attain, to absolute truth; and, so far as he knew, no other human agency sought that truth from such pure motives as the learned societies. Whatever might be the consequence of those researches, they sought truth and truth only. He therefore proposed this toast, coupled with the name of the President of the Royal Society, Sir George Stokes.

Sir GEORGE STOKES, in responding, said the toast of "The Learned Societies" was a very wide subject, if they took in all the institutions which deserved that name. From the nature of those institutions, and from the speech of the gentleman who proposed that toast, he supposed it was not meant to include in that term literary and philological societies, but to confine themselves more especially to scientific societies; though here the field was somewhat limited, because there was another toast which would be proposed in due time—the kindred societies—societies kindred

to the Electrical Engineers. It was quite true that there were societies who had claims to abstract discovery of scientific truth, apart from its applications. These discoveries, he had no doubt, formed the groundwork of subsequent applications, and there were many such societies, due to particular branches of science, with which electrical engineering was brought more especially into contact. It was brought into contact even with abstract mathematics. It was brought into contact, again, with chemistry, that strange agent which they had to deal with and turn so much to practical account, for electricity, as they knew, was intimately bound up with chemistry. Circumstances at the present led him to look more to the future than to the past. No doubt his name had been connected with this toast in consequence of the honourable office which for the present he was filling; but his tenure of that office was now drawing to a close, and in a few days he would cease to hold it. Perhaps he ought not to name his successor, because that was determined by the votes of the fellows, and those votes were given by ballot; yet he thought it was what he could call an open secret that in all human probability his successor would be one who, though somewhat his junior in age, he could look up to as his master in science, and more especially in electricity. He was one well acquainted with them, and he had already filled the position which his friend on the right occupied at that very moment. With that he would say no more.

Mr. W. H. PREECE proposed "The Kindred Societies," and said that there was every reason to hope that the next President of the Royal Society would be Sir William Thomson.

Mr. GEORGE BERKLEY, Vice-President of the Institution of Civil Engineers, responded, and referred to the cordial intercourse which existed between American Engineers and those of this country, pointing out that after a visit to the United States one came back with the feeling that this country was somewhat behind in adopting the advantages which electricity conferred.

The PRESIDENT proposed "Our Guests." Referring to the Attorney-General, he said that there was no one by whom it was more pleasant to be examined in cross-examination; but, whether as friend or as foe, in time one's admiration for his strength and judgment was almost overshadowed by a respect for his honesty of purpose and firmness. They would also find that the honourable and learned gentleman knew a great deal about electricity, and that he had consented to join the institution. Their other guest was Dr. Coleman Sellers, member of the International Niagara Commission, who having attained to the highest eminence in other branches of science, was considering the problem of utilising to a useful purpose part of the vast energy which was going to waste in the falls of Niagara.

The ATTORNEY-GENERAL on rising was received with loud applause. He said: Mr. Chairman and Gentlemen,—I feel it a great privilege to have been selected as one of two who are to respond on behalf of the gentlemen who have been invited here to-night, and I honestly wish that by some process of induction or otherwise I could worthily represent the feelings of thankfulness which, I am sure, are in the breasts, or some other part, of the persons of the gentlemen who have enjoyed the excellent dinner that has been set before them to-night. I fear, though, that had they known that I was to be selected as a speaker on their behalf they would almost have resented it; for they have heard, on no less an authority than the Postmaster-General, that my law is as bad as my electricity. I confess I shall go out of this room to-night a sadder and, I trust, a wiser man, determined by some process or other to endeavour to imbibe, if not a little more law here, a little more electricity, which may conduce to a higher standard, up to which I may direct my law. My excellent friend Dr. Hopkinson has spoken in kindly terms that there are many in this room whom I have met in combat. I have always liked to see them on my side, and when they were opposed I regarded it as a temporary misfortune as far as I was concerned. I confess I never knew before that I was going to join the society because I was an electrician. I was asked by a very distinguished electrician, no less a person than my friend Sir David Salomons, whether I would consent to become a member. I said, "I thought you only admitted great electricians." "Oh," he said, "we take duffers as well." (Laughter and applause.) On these terms I felt that there were some possibilities of my being not blackballed but elected. It is not for that reason only that I have a very great desire to improve my knowledge of electricity, and I think that if I were to dine here more frequently, to sit between Mr. Latimer Clark and Mr. Preece, that some secondary currents might possibly find their way into my miserably insulated body—perhaps I ought to say, my perfectly insulated body, so far as electrical ideas are concerned. Years ago I studied secondary batteries, or tried to, and I think they represent my constitution. My excellent friend Mr. Crompton told me that I was no good; I charged very well, but discharged much too rapidly. (Laughter and applause.) I am at the present time in a state of despondency, because not very long ago, while considering some of these abstract problems, I met Prof. Forbes, and I explained to him my condition. After looking at me very carefully he said, "You are wound the wrong way, you want re-winding." (Laughter and applause.) I am possessed by the hope that some subtle agency will possibly do something for me. I have thought that I might venture to ask for admission within these sacred portals. I hope that many of the guests on whose behalf I have spoken will follow my example. I can assure you that it has given us much pleasure to be here, and we shall be only too glad to be your guests on any future occasion.

Dr. SELLERS (America), in his speech, referred at considerable length to the project of utilising the waters of Niagara.

Mr. RAIKES, in proposing "The Institution of Electrical Engineers," pointed out that the Institution of Electrical Engineers then called the "Society of Telegraph Engineers," was founded in 1871. The total number of members of all classes in 1872 was 268. In the present year it was 1,738, an increase of 1,470. In 1872 there were only two "students" in the list, whereas now there were 102. The students generally were young men employed by companies and firms of one kind or other. They benefited by hearing the papers read at the ordinary meetings of the institution, but they had also a special organisation, and held meetings of their own. Sir David Salomons, a member of the council of the institution, had recently founded an exhibition for the benefit of the students. The exhibition was awarded, after a suitable examination conducted by the staff of one of the technical colleges. The institution had an invested fund of £2,300, and might now be considered as occupying an assured position. Referring to matters in which electrical engineering concerned our daily life, he recalled the system of block signals on railways, and the great advantage of synchronising time in the most distant parts of the kingdom, and thus securing one cardinal time. This was of enormous benefit in regulating all sorts of matters connected with daily life and ordinary commerce. It was to the electrical engineers that they owed their system of 120,000 miles of submarine cables, and within the limits of these islands 2,000,000 miles of telegraphic system. That did not, he believed, include the telephonic systems, but on this burning question he would say as little as he could; with the expiry of the telephone patents in the course of the next year or two, a fresh field would be opened for the inventive genius of electrical engineers.

The PRESIDENT briefly acknowledged the toast, after which the company separated.

## CORRESPONDENCE.

### The Electro-Deposition of Copper.

I would have been content to leave this matter to the judgment of your readers, having clearly set out eight points in which your objections to the process were in my opinion unfounded, and which eight points remain unanswered.

You, however, imply by your note in last week's issue, that my meaning was not clear to you, and I will therefore restate with greater fulness the points which dispose of your previous criticisms upon the process.

1. Your calculation of the current necessary was "practically ridiculous," because

(a.) You assumed 60 hours per week instead of the usual 156.

(b.) You assumed that the whole of the depositing goes on in one tank, which is, of course, out of the question.

By these two assumptions you arrived at the enormous figure of 287,620 ampères, a current which, if correct, would certainly be a serious objection in practical work.

The correct figure is somewhat less than 3,000 ampères, as appears clearly in Dr. Hopkinson's report from which you have quoted.

The following extract from *Nature* (January 26th, 1888, p. 303), endorsed by Dr. Gore in his well known book (p. 7), is further confirmation of my contention. "Messrs. Bolton at Widnes, and Messrs. Vivian, as well as Messrs. Lambert at Swansea, are each depositing 40 to 50 tons per week by currents [of] from 5,000 to 10,000 ampères."

2. Your calculation of the resistance of "the bath," founded upon the necessity of a current more than 90 times as great as that actually necessary, is consequently incorrect in the same degree; and the fact of your making this calculation shows distinctly that you contemplated the work being done entirely in one bath or on one circuit, which, I repeat, is practically out of the question.

3. The necessity for this enormous "bath" conceived by you therefore disappears in reality, and I may add that the size of the tanks in the Elmore process has never presented the slightest difficulty.

None of the "eminent scientists and authorities," quoted by you, have written a word that will support your contention that "20 tons per week would involve the use of enormous tanks worked under conditions

that would be impossible except by a heavy outlay for plant and tank space.

4. As a proof of your wisdom in accepting my view as to the practical range of current-density, I would again refer you to Dr. Gore (p. 208), where he says, "the range of variation in these cases is from 0.82 to 10 ampères" [per square foot].

You add that you fail to see the force of my contention. It is this, that the weight of metal that can be deposited in a given time with a given tank plant is, *ceteris paribus*, proportional to the current density which is feasible, and therefore the higher current density in the Elmore process effects a corresponding economy in tank plant.

5. You have not been able to deny the correctness of my criticism.

6. Again, you do not deny my statement but rely upon a quotation from Mons. Fontaine's book, which applies to the state of the industry more than five years ago. Your quotation is now entirely misleading, for, as I stated, the cost of refining a ton of copper cannot be £12, inasmuch as the market price does not exceed £8.

7. I am glad that you disclaim any intention to reflect upon the quality of the articles produced by the Elmore process.

The belief expressed by me, as to the profit to be made in the manufacture of wire by this process, is founded upon facts which have already appeared in an article in your journal, and upon opinions expressed by manufacturers of many years' experience.

8. In confirmation of my statement that competent authorities had verified the correctness of the statements, which have been made with regard to the cost and quality of the articles manufactured, I enclose you a copy of the report, by publishing which you will oblige me.

I may mention that Messrs. Vigreux and Bourdon are professors at the Central School of Arts and Manufactures of France, and were respectively head and assistant engineers in the Mechanical and Electrical Section of the Paris Exhibition of 1889. Mons. Secretan's practical knowledge of the subject is beyond dispute.

With regard to your demand for a detailed statement of the cost of manufacture, the Elmore Company have, in the exercise of their undoubted right as manufacturers, objected to these figures being given by me.

W. Stepney Rawson.

November 19th, 1890.

### Report of Mons. Eugene Secretan.

[TRANSLATION.]

17, Boulevard Beausejour,  
Paris, October 15th, 1890.

To the President and Members of the Board of  
The French Elmore Company, London.

Gentlemen,—In accordance with what was agreed at the last board meeting, Messrs. Vigreux and Bourdon, members of the committee, and I, went to the factory at Leeds to inspect it, and to make ourselves definitely acquainted with the value of the Elmore process, and of the cost to manufacture by it.

My colleagues and I have been able to satisfy ourselves that the figures that were given to us were perfectly exact, and the experiments we made upon articles manufactured before us demonstrated to us in the most absolute manner the high qualities of the articles obtained by this process.

\* The statement which accompanies this is prepared upon the supposition that at least 900 tons per month are made—an amount which it is easy to reach in a very short time.

The expenses set out in this statement are taken at the maximum, and cannot be exceeded, but, on the contrary, can be reduced when a definite project is prepared.

The receipts have been taken certainly at the minimum, as the prices calculated are based only upon very low figures, and below those which are currently quoted.

My colleagues and myself, as well as the very able technicians men who accompanied us, have no doubt that the Elmore process

\* The statement referred to is a long and detailed technical report on the cost of production and prices to be realised.

will permit of the economic manufacture of articles which are sold at very high prices, and this would form a large revenue not included in our calculations.

Now, the above being well established, it is necessary [to] take immediate steps to commence work, and I therefore beg of you, Gentlemen, to take into consideration at the very first meeting of your board the following proposal, and to adopt it in principle.

However, you may find it is more prudent to decide for the moment on the construction of a factory capable of only turning out 300 tons per month, and this course I now propose.

I am certain that as soon as this, the first part of our programme, is executed, and the board can take stock of its success, they will not hesitate to give orders to obtain the necessary plant to increase the output.

To arrive at these results, of which there is not the least doubt, work must be undertaken. To work, plant and material in sufficient quantity are necessary, and I therefore beg the board to give me without delay the necessary instructions and means to enable me to proceed.

This being decided upon, one can, without rashness, predict a brilliant future to your company. What is here written is more over a justification of the heading of the prospectus, calling the Elmore process "a revolution in the copper industry."

I beg of you to accept my high consideration,

The General Manager,

E. SECRETAN.

"After having read the above report we approve the contents, and we declare ourselves very satisfied with what we have seen at Leeds."

L. VIGREUX and C. BOURDON.

The abstract of the specification of Mr. H. Wilde's patent of 1876, for electro-coppered iron rollers, which appeared in the last issue of the ELECTRICAL REVIEW, induces me, as one closely associated with Mr. Wilde in the development of his invention and its successful working, to bring under notice some facts connected with the history of the subject which may be of interest, and correct any wrong impression prevailing as to the value of the burnishing process described in the specification. The principal feature in Mr. Wilde's improvements in the electro-deposition of copper in cylindrical forms was the imparting a rapid rotatory motion to the electrolyte or depositing liquid in which the roller is immersed, in order that fresh particles of the electrolyte might be brought into contact with the electrodes. By this means powerful currents of electricity could be brought to bear upon small surfaces of metal, without detriment to the quality of the copper deposited, while the rate of the deposit is greatly accelerated. This improvement formed the subject of Mr. Wilde's patent of December, 1875, No. 4,515. The copper deposited by the new process was superior in tenacity and other qualities to that produced by any other metallurgical process, as was evident from the turnings off a cylinder, which had the ductility of well annealed copper wire, and could be reeled off during the process of turning in lengths of hundreds of feet. Great density was also given to the electro-copper cylinders by submitting them to the action of a steel burnishing roller, and when no special means were taken to secure adhesion between the metal surfaces, the iron and copper cylinders readily separated themselves by the milling or burnishing process. I have now before me a 400 feet length of a copper wire turning, and an electro-copper cylinder, 36 inches long, and 5 inches in diameter, produced in the manner described, 14 years ago.

As the production of separate copper cylinders was not the principal object Mr. Wilde desired to attain, but a compound roller of iron and copper inseparable from each other, as a substitute for the solid copper rollers used in calico printing, it was found that, by depositing one or more thin coatings of copper on the iron before the thicker or final coating, the internal friction of the copper surfaces caused perfect adhesion between the metals, so that the compound rollers would then withstand the heavy milling and burnishing to which they are subjected in some processes of engraving. Soon after the manufacture of these compound rollers was established it was found that milling of the separate coatings was an unnecessary process, and that the

essential cause of the adhesion of the iron and copper surfaces was the separation of the internal coatings, which could be brought about either by exposing the newly-deposited copper to the action of the air, or by a temporary reversal of the electric current.

During the last 14 years these electro-copper rollers and cylinders have entered largely into the industries of the country for a variety of purposes, and thousands of them are manufactured annually by the Broughton Copper Company, Manchester, to whom Mr. Wilde disposed of his patent rights ten years ago. The rollers and cylinders have been exhibited by the company at several industrial exhibitions, including the Electrical Exhibition at the Crystal Palace in 1882, at which Elmore & Co. were also exhibitors of dynamos and electro-plating apparatus. The last of Mr. Wilde's patents expired in September last, so that the public are now at liberty to use whatever there is of value in them for the electro-deposition of copper cylinders and for other purposes. It may, therefore, be taken as conclusive that the art of producing electro-copper cylinders on a large scale and increasing the density of the copper by the process of milling and burnishing has been well known to the industrial world during the last 14 years, except to Mr. Elmore and the astute financiers who use the name and patents of Elmore to conjure with, and take advantage of the unbounded credulity of the general public in the possibilities of electricity.

John Hill.

16, St. Oswald's Grove, Harpurhey,  
Manchester, November 25th, 1890.

P.S.—I am sending by parcel post small pieces of the wire turning and electro-copper cylinder referred to, which you are at liberty to make use of as you may think proper.—J. H.

[We have received the articles to which Mr. Hill refers in his postscript, and very interesting they are; we only hope that his evidence may be the means of opening the eyes of Elmore shareholders to the true value of the stock they hold.—EDS. ELEC. REV.]

#### Overhead Conductor Regulations.

It will interest your readers to know that two memorials have recently been forwarded to the Board of Trade upon the subject of the regulations relating to overhead conductors. The memorials, of which, at the request of members of the firms interested, I enclose copies, explain themselves.

The Brush Electrical Engineering Company, Limited.

R. PERCY SELLON, Assistant Manager.

November 24th, 1890.

[COPY]

London, November 6th, 1890.

To the Right Hon. Sir EDWARD MICHAEL HICKS-BEACH, Bart.,  
M.P., President of the Board of Trade.

Sir,—We, the undersigned companies, firms and persons, interested in the supply of electricity in the United Kingdom, beg respectfully to memorialise your Board with reference to regulation No. 9 of the regulations for the protection of the public safety, &c., prescribed by the Board of Trade under the provisions of the Electric Lighting Act of 1889.

With reference to this regulation, the undersigned beg leave to state that it is the general experience based upon numerous actual tests, that for pressure up to 2,000 volts, whether alternating or continuous current, a thickness of one-tenth of an inch of dielectric is unnecessary in conductors of small section.

For conductors having a relatively large sectional area, we are satisfied with the expediency of the Board of Trade requirements, but for conductors having a relatively small sectional area, the disproportion between the conductor and the insulation is so excessive, as not only to render the use of such conductors prohibitory in view of their high price, but actually dangerous in the presence of snow and high winds on account of the very large surface presented in proportion to the total weight of the conductor and its covering.

Four of the principal companies interested in this branch of work,

viz.: The Brush Electrical Engineering Company, Limited; Messrs. Crompton and Company, Limited; the India-Rubber and Gutta-Percha Company, Limited; and Messrs. Laing, Wharton and Down Construction Syndicate, Limited, were represented at the experiments carried out at the works of Messrs. Crompton and Company at Chelmsford, by your adviser, Major Cardew, and their representatives were so thoroughly convinced by these experiments of the reasonable character of their request for a modification of the existing rule, that the above-mentioned companies heard of the receipt by Messrs. Crompton and Company of the letter from the Board of Trade, dated May 30th, with the greatest astonishment and regret.

The undersigned beg leave, therefore, most respectfully to request the Board of Trade to give the decision therein communicated their favourable reconsideration, and to suggest that this rule may be modified in accordance with the following:—

Every high-pressure aerial conductor must be continuously insulated with a durable and efficient material, to be approved of by the Board of Trade, and to a thickness of not less than one-seventh part of the actual conductor diameter, in cases where the extreme difference of potential does not exceed 2,000 volts; but for all higher voltages this thickness must be increased in direct proportion to the increase in difference of potential.

In no case must the thickness of insulation be less than one-sixteenth of an inch, and the cables must have an insulation resistance of not less than one megohm per mile per volt of electromotive force when tested in water at 60° Fahr. (after immersion of at least 60 consecutive hours). This insulation must be further efficiently protected on the outside against injury or removal by abrasion. If this insulation or protection be wholly or partly metallic, it must be efficiently connected to earth, so, however, as not to cause undue disturbance to other electric lines or works by electrostatic induction or otherwise.

The undersigned are willing and anxious to conduct any additional tests which the Board of Trade may wish or suggest, in proof of the contentions herein stated.

The undersigned make these representations while fully recognising the necessity in the interests, not only of the public, but also of the electrical industry generally, that all overhead electric lines should be carried out in the safest possible manner.

We have the honour to be, Sir,

Your most obedient servants,

(Signed) THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED,  
MESSRS. CROMPTON & CO., LIMITED,  
THE INDIA-RUBBER AND GUTTA-PERCHA COMPANY, LIMITED,  
THE LAING, WHARTON AND DOWN CONSTRUCTION SYNDICATE, LIMITED.

[COPY]

London, November 6th, 1890.

To the RIGHT HON. SIR MICHAEL EDWARD HICKS-BEACH, Bart.,  
M.P., President of the Board of Trade.

Sir,—We, the undersigned companies, firms, and persons interested in the supply of electricity in the United Kingdom, beg respectfully to memorialise your Board with reference to regulations No. 2 and 12 of regulations for the protection of the public safety, &c., prescribed by the Board of Trade under the provisions of the Electric Lighting Act of 1889.

With reference to these regulations the undersigned beg leave to bring before the Board the fact that in conjunction with overhead conductors having a small sectional area of copper, the use of suspending wires is not only necessary, but exceedingly dangerous to public safety, on account of the large surface presented to wind and snow, and the great strain put upon the supports.

It is admitted that this does not apply with so much force to the use of suspending wires with conductors of relatively large sectional area, but the undersigned are strongly of opinion that both in the interests of the electrical industry, and in those of public safety, it is advisable that overhead conductors up to a sectional area of hard-drawn copper, equivalent to 7 No. 16 S.W.G. should be run without suspending wires.

The undersigned beg leave, therefore, most respectfully to request the Board of Trade to give their favourable reconsideration to the foregoing regulations, and to suggest that they may be modified in accordance with the following:—

Clause 2. Every aerial conductor shall be attached to supports at intervals not exceeding 200 feet where the direction of the conductor is straight, or 150 feet where this direction is curved, or where the conductor makes a horizontal angle at the point of support. If suspending wires are used, as required in Clause 12, the above intervals may be increased to 250 feet and 200 feet respectively.

Clause 12. Every aerial high-pressure conductor shall be efficiently suspended by means of non-metallic ligaments to suspending wires, so that the weight of the conductor does not produce in it any sensible stress in the direction of its length, and the insulated conductors and suspending wires, where attached to supports, shall be in contact only with material of highly insulating quality, and shall be so attached and guarded, that in case they break away, it shall not be possible for them to fall away clear of the supports.

Provided that where the aerial high-pressure conductor is equal to, or less than, 7 No. 16 S.W.G., the suspending wires shall not be compulsory if the conductor be of hard drawn copper, or other material of equal strength.

The undersigned are willing and anxious to conduct any tests which the Board of Trade may wish or suggest, in proof of the contentions herein stated.

The undersigned make these representations while fully recognising the necessity in the interests, not only of the public, but also of the electrical industry generally, that all overhead electric lines should be carried out in the safest possible manner.

We have the honour to be, Sir,

Your obedient servants,

(Signed) THE BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

MESSRS. CROMPTON & CO., LIMITED.

THE LAING, WHARTON & DOWN CONSTRUCTION SYNDICATE, LIMITED.

### Single-Cord Telephone Switchboards

We much regret that by an oversight we have not replied sooner to the criticism which appeared in your issue of the 31st October of a particular pattern of single cord board by the Western Electric Company, through Mr. Kingsbury. This board, described in your issue of the 24th October, was selected as being the simplest pattern; it is one of large numbers we have made, to sample received, in which accessibility for adjustment and repair, and certainty of action of the indicator drops, are most considered. Mr. Kingsbury has fallen into the error of assuming that this is the only pattern of board made; the dimensions he gives are wrong, a complete 150 line board has a width of 6 feet 2 inches, and not of 15 feet, as he appears to assert. However desirable compactness may be, accessibility must be considered; still, if we make use of the small annunciators shown on the W. E. board 31st October, the S. C. board will be quite as compact.

For the moment, assuming Mr. Kingsbury's list of connecting and disconnecting operations to be correct, it should be noted that the W. E. operations, even when using speaking and ringing keys, need seven movements in all; the single cord board criticised, requires the same number of movements *without* special speaking and ringing keys, but *the movements are reduced to four*, for connecting and disconnecting two subscribers, if these special keys, or their equivalent, are used. Such S. C. boards with small annunciators, and with special apparatus by which only four operations are needed, we are ready to supply.

Telegraph Manufacturing Company, Limited.

November 25th, 1890.

### High-handed Proceedings—(continued).

We have again been requested to insert the following correspondence, but in future we must either summarise the letters or omit them altogether.

Glasgow, November 18th, 1890.

Wm. Alex. Smith, Esq.

Dear Sir,—I learn from Mr. Laid, law stationer, St. Vincent Street, and Mr. Woolfield, Buchanan Street, that you and Mr. Smith, the secretary of the National Telephone Company, called to buy two of my telephones "for export." It seems a waste of money to offer Mr. Woolfield double the price when, by applying to me, you can get a ship load at even less money. If you will give me your marks and numbers, with shipping port, I shall be very pleased indeed to take your order, and as I have nearly 2,000 lying in the Rue Caumartin, Paris, you need not have to wait long for them. Of course you are well aware that these cannot be introduced into this country as a sale till 9th December, but as you represent the National Telephone Company here that is a difficulty that need not stand in our way. You are aware in March last you and Col.

Jackson gave me an order for some which were delivered within 48 hours from Paris, and further, I may say they will be as much superior to your present telephones as Madame Patti's voice is to that of a broken-winded foxhound. May I expect a report from your engineer soon on the Lacombe cell which you asked from me.

Yours truly,  
A. E. MUIRHEAD.

6, South Hanover Street, Glasgow,  
18th November, 1890.

A. Erskine Muirhead, Esq.,  
Crossmyloof.

Dear Sir,—Your favour of this date has just reached me. I observe it is addressed to me as "Chairman of the Local Board," although I have informed you some time ago that for years no such Board has existed.

You have been incorrectly informed that Mr. Smith and I called on the parties named by you.

I have not seen any telephone from you which have not been tested by us long before I heard of your having anything to do with telephones. As to the efficiency of such telephones, you will excuse me when I say I am in a better position than you are to give an opinion.

The cell which you asked me to test for you has not yet been reported upon, but as soon as I do get a report of it it shall be communicated to you. As far as I can judge of it, it, like the other appliances submitted by you, are modifications of forms well-known to us for years.

Yours respectfully,  
WM. ALEX. SMITH.

Glasgow, November 19th, 1890.

Wm. Alexr. Smith, Esq.

Dear Sir,—I have yours of 18th. I called at shop, and as it was re-asserted that you were the person that called to buy the telephones, I can only ask that you will accept my apology and record it as another extraordinary case of mistaken identity. It is, moreover, very odd that the persons calling should say that by exposing those telephones for sale the shopkeeper was placing himself in a position in which the N. T. Company could claim damages, so it might be well if you consult your secretary and find some one has been acting for you to have it put a stop to, as you are aware that it is perfectly legal for anyone to offer (1) a telephone for sale for export; (2) to sell a telephone that does not infringe the patents of the N. T. Company. As regards your third paragraph *re* the efficiency of the "Ader" and "Berthon" telephones compared with the one in use by the N. T. Company, seeing both of us have very high opinions of our own judgment, I would suggest that if you really want an unbiassed opinion on the merits of the telephones, and to have the matter settled *you* will at hazard name a dozen members of telephones from the Paris Exchange, the editor of the *Herald* or *Citizen* will name 12 from the Glasgow Exchange. Those instruments as they stand will be conveyed to Glasgow and submitted to tests as they stand, not to be in any way touched. You can name six of your own subscribers, and I will name other six, or we can take them also at hazard, and ask them to report the results. I will use the Lacombe cells, of which you ask a sample, for trial. As regards the Kilmarnock affair, seeing we are going to fight a more serious battle, I will again make an offer to show your engineer the four telephones there, and trust if they are what I represent them to be, that you will apologise to Mr. Richmond. If they are infringements of your patent, then by all means proceed with your action; however, you will find them what I say they are, and I beseech you to ask your company to leave off the rôle of private detective, as it requires a capacity they seem to lack. I need not again remind you I am running

bronze wires in the principal centres in Scotland, England, and North of Ireland, to which I am fixing "Ader" and "Berthon" telephones. After the 9th December, no microphone will be used at that date, as the "Ader" receiver is quite ample for any distance below 20 miles; but I again offer you a list of those lines, and an order to your engineer in the respective districts to inspect them, and thereby prevent a massacre of some of your *employés*, who might force their way in to see the telephones uninvited.

A. ERSKINE MUIRHEAD.

The National Telephone Company, Limited,  
Glasgow Offices, Royal Exchange Buildings,  
21st November, 1890.

A. E. Muirhead, Esq.

Dear Sir,—I am directed by Mr. W. A. Smith to acknowledge receipt of yours of 19th inst., and to say that he has nothing to add to his letter in regard to the first portion of what you say.

I have to thank you for renewing your offer to allow our engineer to inspect the telephones erected by you, and shall feel obliged by your forwarding the necessary permission to this office, as well as orders to our engineer to inspect telephones you have erected in other parts of the country.

Yours truly,  
D. JOHNSTONE SMITH,  
*District Secretary.*

Glasgow, November 21st, 1890.

Mr. D. Johnstone Smith,  
Secretary National Telephone  
Company, Limited, Glasgow.

Dear Sir,—A very singular incident has happened, viz., that two gentlemen, thought to be Mr. W. A. Smith and yourself, went into Mr. Woolfield's shop in Buchanan Street, where one of my telephones was exposed in the window, with the enclosed card fixed to it. A very fancy price was offered for a pair, but as Mr. Woolfield could not sell them till 10th December, no business resulted, but the mysterious strangers then gave Mr. Woolfield to understand that by exposing those, even for export, he was doing an act that would bring the N.T. Company on him for damages. As you are the recognised chief of the N.T. Company in this city, perhaps you may see fit to disclaim all knowledge on your part, and that of the N.T. Company, of what I hold to be an interference with the liberty of the subject. As you are, perhaps, well aware, the Caledonian Railway Company's telegraph have at least a dozen different types of those French telephones in their possession. If you are not aware, I now take this opportunity to say I am quite at liberty to advise you of the fact, so that if the N.T. Company think they have a legal right to dictate to the Caledonian Railway for being in possession of those telephones, they can try it. It is patent to everyone that the N.T. Company have in this country tried to fill the vacancy left by the Society of Jesus, in the department of espionage and tyranny.

The S.J. had at least the credit of doing anything, however bad, *well*. Their staff contained the best men in every department. I leave it to you to say if yours is up to this standard. You may think it odd that I should insist in having this matter cleared up. I want to show Mr. Woolfield that I have not put him in a false position by asking him to do something that was illegal. I trust you will leave a reply to this, addressed to me at the bar of Royal Exchange, which I will at once show to Mr. Woolfield.

Yours, &c.,  
A. ERSKINE MUIRHEAD.

I may add that a proof of circular, and also the advertisement now appearing in the *Times*, *Standard*,

*Daily Telegraph, Herald, Scotsman, Citizen, News and Scottish Leader*, were submitted to your London office before insertion.

The National Telephone Company, Limited,  
Glasgow Offices, Royal Exchange Buildings.  
21st November, 1890.

A. E. Muirhead, Esq.

Dear Sir,—I beg to acknowledge receipt of your letter of this date, but regret that I do not see my way to enter into any correspondence regarding this.

Yours truly,

D. JOHNSTONE SMITH,  
*District Secretary.*  
*Per J. D. W.*

Glasgow, November 24th. 1890.

Wm. Alex. Smith, Esq.,  
National Telephone Company's Office,  
Glasgow.

Dear Sir,—As you have at least always replied to me, I cannot be outdone by you in politeness. I now beg to enclose order on Mr. J. Richmond to allow your Mr. Aitken to inspect telephones. As regards Woolfield's affair, the "Flying Dutchman," Wandering Jew, or the German Baron must have paid our city a visit. As regards giving your engineer an order to inspect the other lines I am erecting in various parts of the country, it would (1) simply be impossible for him to overtake them before 10th December, as they are numerous, and are scattered over the country between Inverness and Bristol; (2) and, further, when your company came across Dr. Kelly's wire you were able then to offer him terms that induced him to take your telephone, though I hear that he may change his mind again, so you must excuse me declining to show you my hand when your company are so ready to take advantage of such information.

Your truly,

A. ERSKINE MUIRHEAD.

I shall be glad to hear if you have yet tested the Lacombe cell.

Glasgow, November 24th, 1890.

Mr. D. Johnstone Smith,  
Secretary National Telephone Company,  
Glasgow.

Dear Sir,—Your note of 21st is duly to hand. I shall leave it to others to say whether it is a satisfactory reply to my note of 21st.

A. ERSKINE MUIRHEAD.

I have sent your London office a copy proof of enclosed circular. I may leave for London before I have their reply. If they want to see me they can address me at St. Pancras Hotel.

6, South Hanover Street, Glasgow,  
24th November, 1890.

A. Erskine Muirhead, Esq.,  
Crossmyloof.

Dear Sir,—I am directed by Mr. Wm. Alex. Smith to acknowledge receipt of your favour of this date, enclosing order to inspect the instruments erected at Mr. Richmond's, for which he desires to thank you.

He takes good note that you now withdraw from your offer to give similar facilities to the telephone engineers in other parts of the country.

The report on the Lacombe cell is fairly satisfactory, but, of course, its durability can only be tested after a year or two's experience of the same.

Yours faithfully,

D. CAMPBELL.

#### Telephonic Research.

I suppose it has also seemed peculiar to you that none of the text-books, &c., on telephones state the source from which the information is derived that Mr. Yeates, of Dublin, experimented with the Reis telephone, and placed a drop of water between the electrodes. To-day, while going through a mechanical magazine, I noticed an article which is very suggestive, because it says that the *Dublin Medical Press* (presumably of 1864) contains a description of experiments with an acoustic telegraph (presumably Reis's), and says that a membrane at the receiving station was thrown into vibrations corresponding to the vibrations of the membrane at the transmitting station. I enclose the article (in German) just as it appears in journal found by me:—

*Zeitschrift des Architekten Vereins für das Königreich Hannover*,  
A.D., 1866, Vol. XII., page 147.

Neues System A Rustischen Telegraphie. Die *Dublin Medical Press* veröffentlicht einen Artikel über diesen neuen Apparat welcher gestattet die Töne der menschlichen Stimme nach einem entfernten Orte zu übertragen. Man spricht in ein Rohr hinein nahe welchem eine Membrane angespannt ist deren Schwingungen durch den leitenden Draht auf eine gleiche Membrane an der Endstation übertragen werden. Durch die gleichen Schwingungen wird derselbe Ton hervorgebracht und so soll es möglich sein in der That mit einem anderen Welttheile ein Gespräch zu führen.

Article said to be taken from *Nouvelles Annales de la Construction*, 1864, January to September, page 39.

I am not at present in a position to consult the *Dublin Medical Press* (it does not appear to be a widely-disseminated journal, else we would have heard of it ere this). I suppose you will consider the matter of sufficient importance to consult the *Dublin Medical Press*, and give what it states in your Journal? I notice that someone has brought up the *Didaskalia* as being a new thing. I trust I'm not in same boat. Anyhow, the article in German journal (copied from French journal) ought to settle question that Reis had in view transmission of articulate speech. In this I'm a follower of Prof. S. P. Thompson.

A. M. Tanner.

Berne, November 21st, 1890.

**Australian Cables.**—The Hon. John Gavan Duffy, Postmaster-General to the new Cabinet of Victoria, has expressed himself in favour of the cable guarantee, notwithstanding the refusal of Queensland and New Zealand to bear a share.

Public opinion is gradually beginning to assert itself in the mother country as to the desirability of a direct cable from Canada to Australia, says the *Toronto Empire* of November 17th. Readers are doubtless familiar with the discussion which took place in the English Press this summer on this question, and the timely action of Mr. Sanford Fleming, impressing the advantages of a Pacific cable, has already had important bearings. The great shipping agency, Lloyd's, has taken a decided stand in the matter, as the following extract from a letter received by Mr. Fleming to-day from Mr. H. M. Hozier, secretary of that body, shows:—I ought to inform you that my committee have personally drawn the attention of the Prime Minister in this country and of the Chancellor of the Exchequer to the necessity of an alternative telegraphic route to Australia and the East by means of a telegraphic cable across the Pacific, and I am sure that my committee will be most happy to bring this matter forward and give it their assistance in every way in their power on all occasions.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## OVERHEAD LINES AND THE BOARD OF TRADE.

THE two memorials to the Board of Trade, copies of which were published in the correspondence columns of our last issue, show that a wide difference of opinion exists between that Department and some important manufacturing and contracting firms with regard to the precautions necessary for the erection of a safe overhead line. Whilst agreeing with the memorialists that a change is certainly necessary, we cannot help thinking that they have not made as good a case as was possible; and we hope, therefore, that if, as is probable, the Chamber of Commerce takes the matter up, it will, before addressing the Board of Trade, make an exhaustive enquiry; and by obtaining the views of all manufacturers and contractors who have had practical experience with overhead conductors, be enabled to present a strong and well-stated case. Had such a plan been followed by the committee of the Council of the Institution of Electrical Engineers, when the regulations were first submitted to them, the need for amendments so soon after the issue of the rules ought never to have arisen; but, instead of acting in this manner, a committee of gentlemen, who were either without the necessary experience, or had not sufficient personal interest in the questions involved, appear to have approved of the proposed regulations in the name of the whole trade, without ever realising in the slightest degree what it was to which they were agreeing. Naturally this approval of the regulations may be used as an argument against the proposed amendments, and it therefore behoves the trade generally to try and arrange a new *modus operandi* by which they shall secure to themselves the right of being consulted by the Board of Trade before any regulations affecting their business are promulgated.

The first memorial deals with the regulation specifying the thickness of the dielectric, and a brief consideration of the requirements of a safe overhead conductor shows that these are; (1) a sufficiently

high insulation resistance to render accidents practically impossible through direct leakage, if the outer covering of the cable comes in contact with a human being or another wire; (2) a sufficient thickness of insulating material to allow of the necessary handling during erection without damage to the cable; and (3) the protection of linesmen and others from shocks due to the discharge from the exterior surface of the cable of the charge which is induced thereon.

So far as accidents from direct leakage are concerned, ample experience has been gained in working high-pressure alternating circuits underground to show that a thickness of one-tenth of an inch of insulating material, if of suitable quality, is quite unnecessary for the smaller sized conductors; and we may here draw attention to the fact that, so far as guarding against accidents from this cause is concerned, the Board of Trade regulations are quite insufficient, since they specify a uniform thickness of dielectric, irrespective of the size of the conductor, or of the nature of the insulating material employed. The only reasonable form of specification for dealing with this condition is such an one as is proposed in the memorial, viz., that the cables shall have at least a certain minimum insulation resistance per mile, when tested under the best conditions for discovering the existence of faults.

The insulation resistance proposed by the memorialists appears to us sufficiently high to meet all practical requirements, and if a clause were added specifying that during immersion the cable should be subjected to a difference of potential at least equal to that at which it is to be used, we think that no reasonable objections could be offered to the proposed amendment on the score of danger from direct leakage.

The second requirement has to do with the mechanical strength of the insulating material, and here again the experience of all work done, whether indoor or outdoor, underground or overhead, shows that small cables with much thinner insulation than that specified can withstand a considerable amount of rough usage.

Many of us have seen cables with even less than a

sixteenth of an inch of insulating material pulled into pipes, bent round corners of small radius, straightened out again, and subjected to other such treatment without injury; and, were it only this that had to be looked to, we would say that the thickness now suggested was more than was necessary; but there is another matter, which is really one for manufacturers to speak on, and is dependent on the excellence of their machinery, and the care with which their work is done, and that is the difficulty of being absolutely certain that throughout a long length of cable the covering is perfectly even and homogeneous. We believe that excellent results are now obtained in this respect, but for all that we think that, when high pressures are to be used, it is well to err a little on the safe side. A fault due to a slight unevenness in the covering would not show any perceptible difference in the measured insulation resistance; but the test at high pressure already suggested should discover it, if sufficiently bad to be in the slightest degree a cause of danger; and this test, together with the thickness of dielectric now proposed, should be a sufficient safeguard against accidents caused by mechanical faults.

Generally speaking, so far as the two conditions of safety already spoken of are concerned, there is no reason why any difference should be made between underground and overhead cables; and it is therefore, we suppose, with a view to guarding against accidents from discharge that the greater thickness of dielectric is specified. This particular source of danger does not appear to have received the consideration due to it; otherwise the attempt to get rid of it by simply thickening the insulation would not have been made. It is true that an increase in the thickness of the dielectric will decrease the discharge, other things being equal; but a far more important factor in practice is the extent of surface in electrical contact with the discharging circuit. When the outer covering of the cable is dry, and therefore the contact surface is practically limited to the amount covered, say, by a man's hand, no unpleasant results need be apprehended with the ordinary class of cable and a pressure of 2,000 volts; but should the outer covering be wet, so that the surface is a fairly good conductor, the man's hand would really be in contact with a considerable area, and an unpleasant shock would certainly result, even with cables covered with a tenth of an inch or more of insulating material. We are not aware of any exact measurements having been made; and as it is not desirable that they should be first made, when a human being is the measuring instrument, we would commend this matter to the notice of manufacturers and others, who have the necessary appliances for making tests, in the hope that they will be able to supply further information.

The insulated suspending wire, which is connected at frequent intervals by non-metallic ligaments to the outer coating of the cable, will, when these ligaments are damp, be just as unpleasant to touch as the cable itself; being, in fact, under those conditions, equivalent to a metallic sheathing. Now, we find it specified that when a metallic covering is used, that covering shall be

efficiently connected to earth; and the same reasoning, which shows this to be necessary, should also require the earthing of all suspension wires. Such a course of action, by providing an easier path for a discharge than through a human body, would supply the necessary safeguards against accident.

The other regulation, to which exception is taken, is that relating to the use of suspending wires; and here we consider that a grave mistake has been made, since the Board of Trade is asked to make the use of suspending wires optional with cables where conductors are not larger than 7 No. 16; whilst no notice is taken of the regulation concerning the wind pressure to be allowed for, a regulation which, if it remains in force, will render the proposed alteration inoperative; since, as a little calculation would have shown, these smaller cables cannot be used without suspending wires for spans for anything like 200 feet, when a wind pressure of 50 lbs. per square foot, and a factor of safety of six have to be allowed for. We do not propose to enter into any discussion of this question, as in a recent issue\* we printed an article on this subject by Mr. Russell, which showed how much the requirements of the Board of Trade were in excess of what has been previously considered sufficient for safe work; but we think that all efforts should be directed to getting the wind-pressure clause amended, and that until this is done, it is futile to discuss the question as to whether suspending wires are necessary or not in particular cases.

In concluding our present remarks, we would congratulate the trade on the fact of some steps having now been taken to get these regulations amended; steps which, we hope, will lead to a more satisfactory arrangement. We are, however, surprised that the firms whose signatures are appended to these memorials should have been content to put their case before the Board of Trade in such a feeble manner; more especially when we consider that two of them are connected with the manufacture of cables, and should have sufficient experience to enable them to present a much more forcible memorial, and one that could not but carry great weight with it.

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#### Galvanometers.

THE proceedings of the Physical Society recently published, contain the interesting paper of Prof. Ayrton, Mr. T. Mather and Mr. Sumpner on "Galvanometers." The whole history of this valuable and indispensable piece of electrical apparatus would form a voluminous work, and might be appropriately dealt with by that indefatigable electrical historian, Prof. Silvanus Thompson. Attention to various points of detail has vastly improved the original form of the Thomson reflecting instrument, though it is surprising how closely in general form the early patterns have been (and wisely so) adhered to. There is still room for improvement, however; the hinging of the coil frames is one most noticeable change that has been marked within the last 20 years, but we find that the absurd arrangement of bringing out the coil

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\* ELECTRICAL REVIEW, 24th October, p. 489.

ends near the centre of the coils is still adhered to, the result being that the coils cannot be swung on their hinges without having to disconnect the ends of the wires from the terminals to which they are attached; if this is not done the spiral connections are pulled out of shape, and in any case are made very untidy. The spiral connections ought, of course, all to be led to and brought out close to the hinges where the movement is least, and we are surprised that this has never been done.

#### Submarine Telephony.

IT is surprising how little the conditions for telephonic working through underground or submarine wires seem to be grasped by numerous so-called electricians; one would have imagined that the law was as well known as that of Ohm. That the product of the total capacity in microfarads and the total resistance in ohms of the line, or its "KR," must not exceed a certain value is a simple and easily recollected law. What this value is, depends upon circumstances; but its average value for good speaking is about 10,000. This figure is known to be correct as the result of numerous experiments, and it disposes of the absurd notion that some people have, that telephoning through a cable several hundred miles long is possible.

#### The Censorship of the Board of Trade.

A CORRESPONDENT writes:—"In the latter part of one of your leading articles entitled 'State Control,' the action of the Board of Trade with reference to electric lighting is severely criticised, but not so severely as it deserves, for that would be impossible. Your remarks would bear repetition again with special reference to the overhead wire question. I think it perfectly scandalous that after electric lighting has reached its present stage of progress by private enterprise and individual effort, the Government should step in with its grandmotherly legislation and restrictive policy and so hinder future progress. But it is always the same. Officialism does act always so, must in fact act so, though people cannot see it until by getting the Government to interfere in their affairs they make a rod for their own backs. The scientific adviser to the Board of Trade knows nothing about practical electric lighting, save what those he now dictates to have taught him, small claims, I think, for so important a position."

#### Projected New Telegraph Lines.

THE *South American Journal* of 29th ult. says:—"Mr. E. Barra has applied to the Government of the Argentine Republic for the privilege to build a line of telegraph from Buenos Ayres to the Cordillera, where it would join another line to the Pacific. This line is intended to compete with the Transandine Telegraph." It is also announced that the *Diario Oficial* of October 30th contains a ministerial resolution issued by the Department of Public Instruction, Posts and Telegraphs, authorising the Western and Brazilian Telegraph Company to lay a duplicate cable along the coast of Brazil. The Chilean Government has accepted a tender for the construction of a line of telegraph between Tongoi and Tamayo.

#### Insulation of Under- ground Lines.

AT a recent meeting of the Berlin Electro-Technical Society, M. Grauwinkel read a paper on the condition of underground lines belonging to the Administration of Posts and Telegraphs of the German Empire, describing at the same time the system adopted in the various tests. In contrasting the results of tests taken during 1889 with those of former years, the author is forced to come to the conclusion that the much lower insulation observed in the gutta-percha core more recently laid down, as compared with the insulation obtained originally on the older lines, is due to nothing else but the inferior quality of the gutta-percha now employed; a consequence resulting from the enormous demand for this material.

#### The Testing of Insulated Wires and Cables.

THE first instalment of a series of articles under the heading of "A Practical Guide to the Testing of Insulated Wires and Cables," written by Mr. Herbert L. Webb, appears in the *New York Electrical Engineer* for November 19th, 1890. So far as the subject is at present carried, we fail to see that the treatment is in any degree more simple than that to be found in many text-books, Culley, for example, although the *raison d'être* of the article is nominally for the purpose of assisting the "budding expert" to grasp the rudiments of electrical testing. Perhaps as the matter advances we may find reason to alter our opinion. We must admit that it is rather early to come to a conclusion.

#### A Candid Statement.

IT is not often that a journal devoted to gas matters makes a candid statement regarding electric lighting, but the *Gas World* in its last issue has done so. In referring to the financial position of the Swan United Electric Light Company, our contemporary says:—"Go where we will, however, this fact stares us in the face, that electric light companies are getting customers in quarters where formerly gas reigned supreme. Whether they will be able to retain these customers, or whether these customers will continue to pay the high price which must be charged to earn dividends, are different questions. All we can say is, that when the two illuminants come into competition the gas shareholder does not suffer, that is, if the manager or engineer keeps abreast of the times and pushes business in quarters hitherto neglected."

#### The Electro- Deposition of Copper.

THE lengthy letter of Mr. Desmond G. FitzGerald, which appears in our correspondence columns, relieves us of the necessity of replying at length to an esteemed trans-Atlantic contemporary, to whose criticisms we briefly referred in our last number. We would recommend both the *New York Electrical Engineer* and Mr. Stepney Rawson to peruse Mr. FitzGerald's communication, which may tend to make both parties moderate their transports. In connection with this matter we cannot refrain from again mentioning how curiously alike are the contents of Mr. Rawson's recent letter and our contemporary's leader.

## SOME FACTS CONCERNING GUTTA-PERCHA.

In a previous issue (November 21st) we gave a brief description of the conditions attending the gutta-percha industry. The last number (22nd November) of *La Lumière Electrique* contains the first instalment of an article from the pen of M. Sérullas upon the same subject. The author, it appears, is exceptionally well qualified to discuss the question in all its bearings, as not only has he made a special study of the gutta-percha trees, from a botanical point of view, but he was also engaged, between the years 1884 and 1889, in extensive exploration and comprehensive research throughout the gutta-percha producing districts.

The author describes the extirpation of certain varieties of the gutta-percha tree, and explains the difficulty now experienced in obtaining the best gums in any appreciable quantity. He incidentally mentions the fact that two French manufacturing companies were compelled to abstain from competing for cables between France and the north coast of Africa, recently offered to tender by the French Government, owing to the scarcity of gutta-percha of a suitable quality.

M. Sérullas affirms that absolutely no percha, free from adulteration with inferior mixtures, now leaves the forests, and he describes how the natives bring to their villages, for the purpose of general mixing, all sorts and conditions of low-class gums. He further shows that the second-class gums are becoming as scarce as the better variety, and that now the percha quoted as being of the best quality is not even equal to the classes which originally figured as third rate.

Although, the author continues, many European merchants, at the centres of exportation, pride themselves on their intimate knowledge of the attributes of the various gums which come under their notice, they are but children in the hands of the native collectors and of the Chinese middleman. And in addition to the devices and tricks which the gums are subjected to, the difficulties attending the selection of gutta-percha are further increased by the great differences presented by the same species due to the particular locality of growth, the age of the plant, and the method and season of collection. It is consequently impossible to place any reliance upon the supposed quality of gutta-percha, even when carefully selected for employment in its most important rôle, that is to say, as the dielectric in submarine cables; the adulteration or mixture of various and inferior gums follows no rule, no proportion, either as to quality, quantity, or species.

M. Sérullas states that after a laboured study of the various gums, he has succeeded in arriving at an analytical method, by which he is able to determine the qualities of mixtures of gums recently collected; but this method cannot be depended upon to indicate the quantities of the component parts, and it is completely at fault with regard to old mixtures. With the latter, chemical reactions, electrical tests, spectral analyses, and microscopical examination, are ineffectual, although in certain cases the presence of secondary resins, and the results of the separation of the glucose colouring matters which stain the gums, may indicate the existence of such and such a gum in the mixture, but that is all.

A gum, such as that obtained from the *Minuesops Balata*, almost entirely composed of the fundamental hydro-carbons of the guttas, is not invariably the one which will be longest in changing. A remarkable fact connected with gutta-percha is that two mixtures, exactly similar in all respects, are quite likely to give very different results after the lapse of a few months. Hence, M. Sérullas says, it is not to be wondered at that different portions of a core, in all of which the same percha is supposed to be used, may develop very dissimilar characteristics, even in a comparatively short period.

Gums of low quality, even when pure, behave with regard to their constancy and lasting properties in the same manner as mixtures. And with respect to oxida-

tion, and to the combination of elements and atomic distribution, a very interesting question presents itself as to the changes in molecular equilibrium to which these substances are subject.

The *Isonandra Gutta*, or *Isonandra Percha*, the most valuable of the family of guttas, is also the one most infrequently met with. It will not grow near the sea, nor at a height of more than 200 feet above the sea level, and, although it requires constant humidity, it does not thrive in the neighbourhood of stagnant water. It is almost exclusively found in shallow ravines where the soil is of a compact clay, and where the roots can seek running water. Other reasons besides those connected with climate and locality combine to make the *Isonandra* scarce. The reproduction of the species by seed never occurs at any considerable distance, the young plants being always found grouped close around the adult trees. The seeds not only very quickly lose their germinative power but when ripe are eagerly sought for by many of the birds and beasts of the forests.

In addition to the wholesale cutting down of adult trees, and of the second growth before it attained maturity, for it has been the practice for some considerable time to cut trees only 10 or 11 years old, the reckless clearing and burning of the forests for the cultivation of gambier, and in Borneo for coffee planting, in Sumatra for coffee growing, and in the Malacca peninsula in the search for tin, have contributed towards the extirpation of the *Isonandra*, for though the jungle grows again after the forests have been burned, the gutta-percha trees do not reappear where fire has once passed.

The serious position in which submarine telegraphy is placed owing to the complete extirpation of the only tree producing a gutta-percha suitable for the core of submarine cables, and the utter failure of all attempts to replace it, for this especial purpose, either by low class gums, or by nondescript preparations, is clearly set forth by M. Sérullas. He points out that all these would be substitutes, are precisely lacking in the very quality which gives its great value to pure gutta-percha of the best variety when used as a dielectric under water, that is to say, its almost indefinite immutability. The author has a good deal to say on this point, but we need not follow him further in this direction, since there is nothing very novel in his remarks, and his contention scarcely admits of controversy.

Some idea may be gained of the tremendous inroads made upon the gutta-percha producing districts of Malaysia from the following figures:—

In 1845 there were imported to Europe 19,836 lbs. of gutta-percha. In 1851 the amount barely reached 30,856 lbs.; but in 1855, when collecting commenced to spread throughout the archipelago, the quantity considerably exceeded 661,200 lbs.

In 1857, there were placed on the Amsterdam market alone nearly 551,000 pounds, which was valued at 3.28 francs per kilogramme, or, roughly, at 1s. 3d. per pound.

In 1870, Malacca and Selangore alone, exported rather more than 220,400 pounds.

In 1879, the quantity imported to Europe reached the enormous total of 4,408,000 pounds; of this amount, Sumatra contributed 297,540 pounds, Borneo 2,865,200 pounds, and the remainder principally came from Padang and Perak.

The gutta-percha brought to the Singapore markets in 1879-80 was double the quantity sold in that place in 1869-70; but since 1880 there has been a considerable and continual decrease. M. Sérullas is not very explicit as to the dates when the various districts despoiled of gutta-percha trees ceased exportation. This information would, perhaps, be difficult to obtain with any degree of accuracy; but we gather that all collecting ceased in Singapore in 1857, in Malacca and Selangore about 1875, and in Perak between 1883 and 1884. These districts, it should be remembered, had been amongst the most fruitful in their yield.

It was not until 1883 that the British Government ordered the cessation of gutta-percha collecting throughout their possessions in the Straits; too late, indeed,

to preserve the existence of the tree. Unfortunately, the method adopted by the natives of collecting the gums attracted but little attention on the part of European Governments until too late to avoid the consequences. The real yield of the gutta-percha tree was unknown until quite recently, and such information as was given, notably, by Dennys, Morton, Von Gaffron, and Schlimmer, led to exaggerated ideas as to the inexhaustible resources of Malaysian forests.

The author, in dealing with the very important question of the yield of sap per tree, points out that even the more moderate estimates of Dr. Burck are greatly in excess of the actuality, and he lays some stress upon the fact that whereas this well-known botanist could only have examined a few trees, and these not under the most favourable conditions, he, M. Sérullas, experimented upon more than 6,000 *Isonandra* of various ages and in different localities.

The *Isonandra* of good quality is not fully grown till 28 or 30 years of age. It then commences to flower, an operation repeated every two years. When mature, the trunk is generally cylindrical, having a circumference of about three feet at a height of 5 feet from the ground. The adult *Isonandra*, under ordinary circumstances, supplies about one-third of a pound of sap. Adopting this figure, M. Sérullas estimates the number of *Isonandra* cut down in Borneo alone during the year 1879 at not much less than five millions.

In attempting to arrive, by reference to the quantity of gum of the best quality exported from Malaysia, at some idea of the destruction of *Isonandra*, it must be remembered that the wholesale cutting of adult trees necessitated, in order to keep up the supply, enormous inroads upon the immature plants, which naturally gave very much less sap per tree than the fully-grown ones.

(To be continued.)

## ON THE NEW STANDARD EDISON ELECTROLYTIC METER.\*

By A. E. KENNELLY and R. S. WHITE.

SINCE the last meeting of the association, the new and improved pattern of the Edison meter has been decided upon, received Mr. Edison's approval, and has been completed by the Edison General Electric Company. It has already been introduced into two stations, Brooklyn and Winnipeg, and the reports upon its behaviour in each case are excellent. There are four standard sizes of these 3-wire meters, Nos. 1, 2, 4 and 8, designed to supply 40, 80, 160 and 320 lamps respectively. Meters of larger capacity than these are made specially. In all sizes, however, the bottles and plates are alike, and of the pattern shown. The spools, too, are alike, making the resistance of the bottle circuit the same in every meter, and the drop of potential in the shunt at full load is the same, namely, four-tenths of a volt.

It is arranged that in the smallest or No. 1 meter, each milligramme of weight transferred represents one ampère-hour of supply, and the transfer is 10 milligrammes per hour on full load. Similarly every meter transfers 10 milligrammes per hour at full load, so that each milligramme of transfer in a No. 8 meter represents eight ampère-hours, and in a No. 4 meter four ampère hours, the number of the meter being the index of the supply in each case.

This greatly simplifies the system, reduces the weight of bottles that have to be daily transported, reduces the stock that the station has to keep in hand, makes only one balance requisite instead of two, and with reasonable care the use of a separate multiplier for each size of meter is not found to be an inconvenience. The

objection has been urged against the system that there is danger in making one milligramme of transfer stand for so large a unit as eight ampère-hours in the No. 8 meter, since an error in weighing or in the proportions of the meter would result in an error in the bill eight times as great as the same discrepancies would produce in a No. 1 meter. Even granting the validity of the objection, however, it is evident that since meters are introduced in the capacity proportionate to their duty, the error in the No. 8 meter bill will only bear the same ratio to the whole amount charged, that the smaller No. 1 error bears to its bill. As a matter of experiment, taking, for instance, a series of tests made with the meters by one of the writers at Brooklyn, the records of a set of Nos. 1, 2, 4 and 8 meters, worked in series, and at intervals for a week on half load for the smallest, or five ampères, one-sixteenth of the load for the largest, showed practically the same results, the No. 8 meter under indicating about 2 per cent.

This high degree of relative accuracy, setting aside all questions of care and skill, is secured by three things; The first is a higher degree of absolute accuracy in general. The old pattern meter is universally admitted to be a faithful and accurate instrument, but the intrinsic accuracy of the new pattern is about three times as great. The only chance for error in the operation of the electrolytic meter, accidents aside, is the variation of resistance in the bottle whereby the true ratio between the currents in the bottle and shunt circuits is upset. The extent of such a disturbance of course depends upon the relative proportions of resistance in bottle and spool. Suppose it were possible for the new bottle to even double its resistance and to become 5 ohms instead of 2.5 ohms, at normal temperature. In circuit with a spool of 46½ ohms, such a change would only upset the balance, and make the record in defect 5 per cent. In the old pattern meter the doubling of the bottle resistance, were such a variation to be expected, would make the readings 15 per cent. in defect.

The second preventive of error in the larger sizes is due to the uniformity in the size of plate. A cause of discrepancy has always existed in a slight gain of the plates in weight independently of the current's action and due to their oxidation superficially. With care this source of error has always been minimised, but with the old meters it increased with the size of the meter, since a larger plate offered a larger surface to oxidation. In the new patterns it is of course a fixed amount in all sizes, and owing to the small area of plate, is in any case very small.

The third precaution against error in the larger sizes is the use of duplicate bottles in the Nos. 4 and 8, as mutual checks which are not required in the Nos. 1 and 2.

Another improvement is in the plates. These are castings of pure zinc alloyed with 2 per cent. by weight of pure mercury. This amalgam has the advantage of being more readily brought into good condition for use than the rolled plate; the trouble of varnishing is also saved.

The only other noteworthy change has been in the solution, which is about twice as dense as in the old bottles.

Mr. Edison has recently completed a mechanical meter on the pattern of one of his early patents in that direction. This instrument is a small motor delicately constructed. The armature commences to rotate as soon as one lamp in the supplied circuit is turned on. The rotation accelerates as more lamps are lit, until at the full load of 20 lamps the speed is 600 revolutions per minute. A counter worked from the armature shaft records the number of rotations, and on duly proportioned dials the supply. The field magnets are kept charged by a feeble current from the mains, while the main current passes through a shunt as in the electrolytic meter, and from the shunt terminals wires pass to the armature. The drop of potential in the shunt at full load is 1.5 volts. The model, though complete in itself, will be slightly modified in detail to suit commercial use, and will then be available for such cases

\* Read at the Convention of the Association of Edison Illuminating Companies.

where a mechanical meter is desirable. Mr. Edison does not consider that a mechanical meter can possibly be as cheap or as reliable as the electrolytic meter, firstly, owing to the necessary frictional error which makes the record too low for very light loads and low speeds, and, secondly, owing to the mechanical wear and tear of the working parts, which will need attention and exchange from time to time; but there are cases in which a direct-reading mechanical meter will be an advantage, and he expects that from the tests and behaviour of this model it will serve the purposes.

The conclusions, drawn from an experience of one year with the standard Edison meter, are as follows:—During the year's work with the new standard meter, we have taken 4,088 incandescent, 853 arc lights, and 244 motor readings—a total of 5,185, and have obtained uniformly good results. In a large number of cases customers have kept tally of lamp-hours, and in every instance expressed themselves as satisfied. A considerable number of tests have shown marked accuracy. The greater despatch and care with which the meter work can be performed has been abundantly shown. The use of small and uniform plates secure, by the balance method, doubled accuracy in weighing and the elimination of the oxidisation error. In brief, our experience with the standard meter shows improved ease and economy in operation with more uniform and accurate results. In so far as a chemical meter "fills the bill," little remains to be said.

It may be interesting to note the use of four Aron meters on our circuit for the past year. The frank, open countenances of these meters have won the favour of the meter man and the confidence of the customer. We may conclude, then, it is in the line of a direct reading dial meter that we are to look for the next advance in the commercial treatment of the meter question.

### THE ELECTRIC RESISTANCE OF BISMUTH IN A MAGNETIC FIELD.

MONS. A. LEDUC has recently been engaged on the problem of determining a mathematical formula by means of which it would be possible to calculate the resistance

$$R_{M,t}$$

of a wire of bismuth placed in a magnetic field of value,  $M$ , and at a temperature,  $t^{\circ}$ , in terms of its resistance,  $R_0$ , at  $0^{\circ}$ , outside the field.

The resistance at  $t^{\circ}$ , outside the field, is well expressed by the general formula

$$R_t = R_0 (1 + k t + m t^2 + n t^3)$$

in which the coefficients vary according to the character of the specimen of bismuth that is being examined.

Under the influence of the field the unit of resistance has been shown to be subject to an augmentation,  $Z$ , which is given by the hyperbolic equation

$$Z^2 + \beta Z - \alpha M^2 = 0.*$$

And this is of such a kind that if we assume  $b = \frac{\beta}{2}$  we finally get the formula

$$R_{M,t} = R_0 (1 + k t + m t^2 + n t^3) (1 - b + \sqrt{b^2 + \alpha M^2}) \quad (1)$$

Leduc has been examining the influence of temperature upon the coefficients  $\alpha$  and  $b$ , and at a recent meeting of the Paris Academy of Science he read a paper embodying the results of his research.

The specimens of bismuth which were examined were of the following nature:—One was a fine thread of metal obtained by the electrolysis of the nitrate; the

other two were wires wound in the form of a double spiral, and were made from metal that had been fused and run into tubes, which were then placed in an oil bath at  $280^{\circ} \text{C.}$ , and slowly cooled down. The metal from which one of these spirals was prepared was the pure bismuth of commerce; in the other case it was specially prepared from the pharmaceutical sub-nitrate by solution in nitric acid, precipitation with ammonia, and subsequent reduction with cyanide of potassium.

On the whole, the results obtained for those specimens were very nearly the same; but the specimen last described had a sensitiveness to magnetism which was superior by 10 per cent. to that of the first, and by about 15 per cent. to that of the second. On the other hand, its resistance outside the field presents a minimum towards  $23^{\circ} \text{C.}$  This specimen was considered by Leduc to be the purest of the three.

The coefficients were both found to vary with the temperature, as indicated in the table below. The influence of temperature diminishes slightly as the intensity of the field increases.

$t$	$18^{\circ}$	$44.7^{\circ}$	$100^{\circ}$	$130.8^{\circ}$	$157.5^{\circ}$
$\alpha \cdot 10^{11}$	221	143	55	33	22
$\beta \cdot 10^3$	263	275	301	316	342

The values of  $\beta$  are given approximately by the formula

$$\beta = 0.258 (1 + 0.000907 \cdot t + 0.00000723 \cdot t^2) \dots\dots\dots (2.)$$

Those of  $\alpha \times 10^{11}$  are given by the formula

$$\alpha \cdot 10^{11} = 288.5 (1 - 0.01455 \cdot t + 808 \cdot 10^{-7} \cdot t^2 - 163 \cdot 10^{-9} \cdot t^3) \dots\dots\dots (3.)$$

But this equation indicates at about temperature  $165^{\circ}$  a change in the curve which experiment does not confirm and according to it  $\alpha$  disappears at about  $209^{\circ} \text{C.}$

Leduc's results are well illustrated by the equation

$$\alpha \cdot 10^{11} = 288.5 (1 - 0.0145 \cdot t + 819 \cdot 10^{-7} \cdot t^2) \dots\dots\dots (4.)$$

$$- 194 \cdot 10^{-7} \cdot t^3 + 141 \cdot 10^{-12} \cdot t^4)$$

According to this equation  $\alpha$  disappears at about  $261^{\circ} \text{C.}$

In spite of the somewhat empirical character of this function and the uncertainty existing in the determination of its coefficients, Leduc considers that  $\alpha$  does disappear and that the influence of magnetism vanishes at the fusing point of bismuth.

The resistance of a specimen of bismuth may be calculated within the limits of Leduc's experiments by means of the formulæ (1), (2) and (3), and probably at temperatures lower than the melting point by means of the formulæ (1), (2) and (4).

It may be added that in the above case we have

$$k = - 57.10^{-5}$$

$$m = 125.10^{-7}$$

$$n = - 10^{-8}$$

In applying this property of bismuth to the measurement of magnetic fields it will be sufficient to know the variations of  $\alpha$  and  $\beta$  at the ordinary temperature, and then they may be expressed by the binomial formulæ.

Thus if we express  $Z$  in thousandths, we may in such an actual case merely take

$$\alpha = 0.00231 [1 - 0.0153 (t - 15)]$$

$$b = 131 [1 + 0.0011 (t - 15)]$$

And this will only necessitate four measurements of  $Z$ , made in two known fields, at, for example,  $10^{\circ}$  and  $20^{\circ} \text{C.}$

**Lighting the Meuse Forts.**—The War Department in Belgium recently appointed a commission to investigate the subject of employing electric projectors for the defence of the forts of the Meuse. The apparatus, which has been made by the Société de la Meuse, was placed in armoured turrets, which protect the *personnel*, and the current was supplied by a dynamo driven by a gas engine. The report of the commission has not yet been published.

\* Vide *Comptes Rendus*. February 1st, 1886, and January 20th, 1890.

THERMO-ELECTRICAL RESEARCHES.

By MESSRS. CHASSAGNY AND ABRAHAM.\*

IN the course of our study of the thermo-electrical elements, the comparison of several couples formed of different metals has furnished us with a valuable means of checking the accuracy of our measurements. This system of check consists in the fact that the values obtained verify very accurately the law of the intermediate metals.

For the known temperatures of the junctions we get, between the electromotive forces of the couples formed by three metals, A, B, C, the relation  $E(A\ C) = E(A\ B) + E(B\ C)$ .

The experiments were arranged as described in a former article.† In order to ensure the same temperature at the heated junctions, the wires of the metals under consideration were soldered at one end into the same mass of copper. The other extremities, which were soldered to copper wires, were kept in vessels of ice insulated by wedges of paraffin.

The experiments related to couples formed of the following metals:—iron, platinum alloyed with 10 per cent. of rhodium; copper, pure platinum.

We will now give the results of an experiment in which the junction was placed in the vapour of boiling water:—

COUPLES.	Electromotive forces observed. volts.
Iron-platinum alloyed with rhodium ...	0.0008945
Platinum alloyed with rhodium-copper ...	0.0001980
platinum alloyed with rhodium-platinum ...	0.0007897

From these quantities we deduce for the electromotive forces of the couples iron-copper, iron-platinum, and copper-platinum, the following values, opposite which we have placed those that were observed directly.

Couples.	Electromotive Forces.	
	Calculated.	Observed.
	Volts.	Volts.
Iron-copper ...	0.0010925	0.0010926
Iron-platinum ...	0.0016842	0.0016842
Copper-platinum ...	0.0005917	0.0005917

This system of check, which was necessary for the continuation of our researches, shows, at the same time the degree of exactness of the measurements.‡

THE ELECTRIC LIGHT AND THE PARIS  
MUNICIPAL COUNCIL.

AT the last meeting of the Paris Municipal Council, it was established that the fire at a café on the boulevard was occasioned by too high electrical tension, and numerous complaints were also expressed as to the large quantity of smoke produced by the plant working the dynamos. A long discussion arose on these two questions raised by MM. Binder and Duplan. The solution, however, as was indicated by M. Lépine, Secretary-General of the Prefecture of Police, did not lie within the jurisdiction of the administration. Still, in order to elucidate the duties of the city authorities in regard to the concessionary companies, the council, on the proposition of M. Ferdinand Duval, invited the Prefect of the Seine, to publish the contracts entered into by the city authorities with the Popp Company for the transmission of power, and with the electric lighting companies. A resolution, proposed and seconded by MM. Stupuy and Morane, was then ordered to be sent to the administration, inviting it to make experi-

ments and trials in order to find a good smoke-consuming apparatus.

We take the following, on the above subject from *Le Soleil*, which it prints under the heading of "The Popp Company":—"The accident which occurred in the cellars of the Grand Café was again spoken of. M. Maurice Binder wished to know the results of the inquiry made by the Prefecture of Police. The Secretary-General of the Prefecture stated that the Popp Company had installed, on its own account, in the cellars of the Grand Café, batteries of accumulators which were used for the feeding of about 1,400 lamps. The accumulators became too highly charged, the apparatus worked badly, which caused an explosion and fire. And it appeared that the same cause had already caused similar effects on several previous occasions, which is the best proof that the surveillance of electrical stations is quite insufficient."

ILLUMINATION BY ARTIFICIAL LIGHTS.

By S. ALFRED VARLEY.

THE report of Sir C. G. Stokes, Lord Rayleigh, and Sir William Thomson, on the respective penetrating powers of oil lights, gas lights, and the electric light through hazy sea atmospheres, has been briefly noticed in the ELECTRICAL REVIEW of October 31st, 1890. The conclusion which was arrived at by the above-named distinguished physicists as the result of carefully-conducted observations is, that the electric light, as exhibited at the South Foreland, has greater penetrating power than the light produced from burning oil or gas.

The purpose of this article is not to criticise in any way the efficiency of the electric light for lighthouse purposes, but to direct attention to certain matters bearing on the subject of general illumination. The object of all artificial illumination is to enable us to see in the absence of sunlight, but the part played by our optical organ seems to the writer to have been very generally overlooked in public discussions on the efficiency of the different systems of artificial illumination.

The amount of light which the earth receives at any given spot is much greater in the summer than in the winter; the light at mid-day is also greater than, say, an hour before sunset; but we nevertheless see practically as well on a bright winter's day as we do in the summer, and we see in the afternoon of a summer's day equally as well as we do at mid-day, the reason being that the pupil of the eye automatically adjusts itself to the amount of light received.

Now, when arc lights are employed for the purpose of general illumination, the brilliancy of the light causes the pupil of the eye to contract, and consequently their actual efficiency is really very much less than that indicated by a photometer.

It would be very interesting if a series of experiments were carried out to determine the penetrating power of quantity, as distinguished from the quality of the light.

The oldest living electrician, as long as he can remember, has been familiar with the terms, quantity, and intensity as applied to electricity, and he has clearly grasped the relationship of the one to the other in electrical phenomena; but the same can scarcely be said of the influence which the quantity of matter in a state of combustion has on the penetrating power of luminous rays through the atmosphere, apart from the actual intensity of the combustion itself.

The penetrating capabilities of a large quantity of burning matter of low intensity were forcibly brought home to the writer in his daily journeys as a schoolboy over Blackfriars Bridge. He was so much impressed with the apparent brilliancy of the lights on the coal-lighters as seen from the bridge on a winter's evening, that he went down to the river bank to ascertain their source, and to his great surprise he found what appeared to be

\* Comptes Rendus de l'Académie des Sciences.  
† Recherches de Thermo-Electricité (Comptes Rendus, Vol. cxi., p. 477, 1890).  
‡ Experiments made at the Physics Laboratory of the Higher Ecole Normale.

very brilliant lights when viewed from a distance were only smoky coal fires burning in iron baskets.

The apparent brightness of open coal fires, when viewed from a distance in a dark night, is undoubtedly in no small degree to be attributed to the behaviour of the optical organ itself. The pupil of the eye under such circumstances is very fully dilated, and consequently receives a large pencil of rays, and these rays being of low intensity, they do not irritate the eye and cause the pupil to contract. Now, it is within our experience that a large number of rays of low intensity entering the eye produces a similar effect on the retina, as a smaller number of light rays of higher intensity, and if the fact be taken into consideration that luminous rays of low refrangibility, such as those which a coal fire burning in the open air produces in abundance, are not nearly so much obstructed as rays of light of higher refrangibility (especially when the atmosphere is hazy), then the apparent superior brilliancy to the eye of a coal fire as seen from a distance over that of a gas flame, or even an electric light, is easily accounted for.

The writer well remembers his attention being directed to a very brilliant light in the distance in the middle of a high road, which impressed the eye as being very much more brilliant than the gas lamps, and he found the light proceeded from the turnpike man's fire-grate, an ordinary coal fire, which was not a very brilliant one.

In the year 1860, or thereabouts, a company, actively promoted by the late Sir Charles Bright, was formed for lighting the streets, buildings, &c., with the oxyhydrogen limelight, and the company lighted for a short time, experimentally, old Westminster bridge. So far as general illumination was concerned, the system proved to be a complete failure, the impression produced being that the bridge was dotted with a number of bright and pretty stars, but that the illumination of the bridge was being effected by the ordinary gas lights.

In the year 1874, speaking from memory, the late Robert Sabine, Mr. Gatehouse, and the writer were experimenting at the British Telegraph Company's works with a Gramme machine of the—at that time—largest size manufactured. The electric lamp was in a glass room on the top of the building looking towards the south, and the day was fine, but the sky was covered with light clouds through which the sun shone.

We had a long wedge of semi-opaque neutral tinted glass for looking at the arc with, the surfaces of the wedge were ground flat and polished, the thinner end being a knife-edge and the thicker end being about half-an-inch thick. When looking through the wedge at about two inches from the thinner end the electric light was just visible to the eye, and a little higher up it became wholly obscured. Now the writer found to his surprise that when he looked at the sun through this wedge the sun could be seen through a considerably greater thickness of the semi-opaque glass than the electric light was capable of penetrating. It occurred to him afterwards that the wedge was possibly largely composed of opaque matter, and that the light passed through what was practically a number of fine pin holes, and that, as when looking at the arc, the glass wedge was not more than 7 or 8 inches from it, the greater percentage of the rays struck the glass at an angle and passed consequently through a greater thickness than they would have done if the rays had been parallel as was the case when looking at the sun. At the same time, it seems somewhat remarkable that the sun's rays after passing through 95,000,000 miles of space, and then through clouds and our atmosphere, should have greater power to penetrate semi-opaque matter than an electric arc light which was only a few inches from the glass wedge.

Everyone who has witnessed a great fire must have been impressed with its powers to illuminate. The writer had the good fortune to see the great fire which occurred in Tooley Street, now, a good many years ago. The dome of St. Paul's, the Monument, and the buildings on the Middlesex side of the river were lighted up magnificently, owing to the quantity of light as distinguished from the intensity of the combustion.

Now the writer would very much like to see syste-

matic experiments carried out to ascertain the respective penetrating powers of coal fires, gas lights, and the electric light through hazy atmospheres, and he would not be surprised if the results obtained from such experiments went to show that, under special conditions, it would be more economical for the purpose of illuminating distant objects, for a given amount of coal to be burned in an open fire grate than to burn a similar quantity in a steam engine, and from the energy developed, produce an electric light.

## ELECTRICITY METERS.\*

By ROBERT SHAND.

BEFORE proceeding to consider the subject of this paper, it may be interesting to glance briefly at the developments which have secured for electricity meters the wide attention they receive, and which have made them important factors in the success of any general system of electrical distribution.

When the incandescent lamp was first introduced to an expectant public, people were quick to recognise its many merits and advantages, and the more consideration they gave the new illuminant, the more apparent became its vast superiority to all other illuminants in use for purposes of interior illumination. It was cleanly, and produced comparatively little heat, the atmosphere was not robbed of oxygen and vitiated with combustion products, as was the case where gas or oil flames were employed, and it could be used in many places where gas or oil would be unsafe. It was perfectly understood, however, by those interested in the development of the new illuminant, that however much it might be admired, however desirable it might appear, its progress into general use would be determined principally by its price. If it cost more than people were accustomed to pay for their light, they would continue the use of the elderly, smoky article, and await the development—that is, the cheapening of the new and cleanly method of lighting. The expense and difficulty attendant on the maintenance of small isolated installations, involving the use of steam, gas, or other engines, dynamos, &c., was such as but few people could afford to incur; so that as long as this presented the only means whereby the benefits of the new illuminant could be secured, it must remain a luxury, the desired development could not be effected, and its progress into use must necessarily be extremely slow and unsatisfactory.

Consideration, then, of the practical requirements for the supply of small consumers, suggested the construction of central stations where electric energy could be generated on a large scale, and which could be fitted with a wide-spreading system of conductors in such a manner, that people so desiring, could have stores, houses, &c., within the area of distribution fitted up, and electric energy placed at their disposal in a manner analogous to that followed by gas and water companies in their supply systems. The construction of central stations promised cheap distribution, and as, at that time, cheap production of electric energy by means of dynamo-electric machines was already an accomplished fact, it was assumed quite generally that electrical energy would almost immediately become available to small consumers; but unfortunately many obstacles, then unforeseen, acted to postpone the realisation of these sanguine hopes.

Towards the end of the year 1886 it was estimated that the total number of incandescent lamps in use in the United States was only about one-half million, all practically supplied on the two and three-wire, low tension, direct system. Then came the development of the high tension parallel system of distribution employing alternating currents and transformers. Many local companies engaged in arc lighting saw the opportunity afforded them to supply incandescent lamps also, and quickly took their places in the new field of

\* New York Electrical World.

enterprise thus opened. They realised that by using this transformer system many of the obstacles that prevented the growth of incandescent lighting on the low tension direct system, in other than districts closely built, were materially reduced. Numerous new companies were organised that made more or less a speciality of the alternating current system. Their activity reacted on those engaged in the development of direct current supply systems, spurring them to renewed and greater efforts than before, with the result that at the present time a conservative estimate places the number of incandescent lamps in use in the United States at over three millions, of which number probably one-third are supplied on the alternating current system. This development still continues, and its progress is so rapid that one cannot be said to risk much in expressing the belief that we are now on the highway toward the realisation of the condition of things eagerly anticipated and hoped for when central station construction was commenced; that is, a distribution of electric energy so cheap and so generally available that all who wish may become consumers and secure its benefits, the one necessary condition being that they agree to pay the exact value of the energy consumed, no more, no less.

This brings us at once to the question, On what depends the value of the electric energy consumed? This question must be answered before we can begin to devise methods of determining the "value received" which it is necessary to know before presenting the consumer with the record of his extravagance—his bill.

The value of the supply depends upon its volume or quantity and the electromotive force or pressure at which it is delivered. The product of the current in amperes by the electromotive force in volts gives the rate of the supply, that is, the power at any time in volt amperes, or watts. The total consumption, therefore, is represented by the product,

$$\begin{aligned} &\text{volts} \times \text{amperes} \times \text{time} \\ &\text{or volts} \times \text{coulombs.} \end{aligned}$$

For example: if we suppose two incandescent lamps in use, each taking one ampere of current at 50 volts potential, electric energy is then being converted into heat in the lamps at the rate of 100 watts per second. Assuming the current and the pressure to remain constant for one hour, the energy converted into heat in the lamps during that hour will equal 100 watts for 3,600 seconds, or 360,000 watt seconds or joules. In practice this quantity would probably be expressed at 100 watt hours. It might also be expressed as 265,000 foot-pounds, or .134 horse-power hours. When an ampere hour is spoken of, the electromotive force or pressure is disregarded, and an expression adopted which it is sometimes convenient to use, what is really meant being a supply of 3,600 coulombs of quantity of electricity. This supply may be delivered in a second, or in an hour, or any measurable interval of time may be taken in its delivery, but so long as the product of the current strength in amperes by the time during which it was supplied equals 3,600, it may be expressed as an ampere hour.

For the measurement of any particular time of the electrical quantities we are considering, numerous beautiful and accurate instruments are available, but these evidently cannot comply with the conditions for ascertaining the value of a supply, extending, it may be, over a month or longer, the reason of this being that they are not furnished with means of constant following and registering its successive progressions. In order to know the value of a consumer's supply with certainty and completeness, an instrument must be provided capable of measuring the two factors of the supply—quantity and pressure—and also capable of making a continuous and cumulative record of the supply as it proceeds. An instrument capable of doing this is called a watt-hour meter, energy meter, or erg meter. When, however, it is considered permissible that the pressure factor be accepted as a constant by which the ampere seconds or coulombs recorded may

be multiplied and the product accepted as representing the energy consumed, then the instruments capable of doing this, of recording ampere seconds or coulombs, are called coulomb meters.

In any parallel system of supply the maintenance of constant potential at all points of supply is the characteristic and most important feature, and, where it is maintained, coulomb meters may do the work satisfactorily, but where the potential fluctuates between limits not necessarily wide, energy meters would appear to be desirable.

In forming an opinion regarding the relative merits of coulomb and energy meters, it must be remembered that what the consumer pays for is energy, and if the potential factor of his supply is allowed to fall, the result will probably be a much greater fall in the efficiency of his supply, whether light or power called for at the point of consumption. It would certainly appear, therefore, that the most scientific instrument, the energy meter, ought also to be the most satisfactory in use, inasmuch as it most nearly measures that which the consumer really pays for. If electrical energy was a material substance, a rarefied combustible, for instance, like its would-be rival, gas, it would then be sufficient that the coulomb-meter measure its volume, temperature and pressure being constant, in order to know the amount of consumption. Electricity, however, cannot be measured by the cubic foot like gas, and since it cannot be measured directly at all, some of the effects produced in the conductor, or in the neighbourhood of the conductor, must be measured; in other words, it must be made to do work of some kind, and the relation existing between the amount of work done and the electric energy necessary to do it having been determined, the one becomes the measure of the other.

The effects, then, which electricity is capable of producing are three in number, viz., chemical, magnetic, and heating, and these three effects or properties mark three lines along which inventors have laboured in the production of electricity meters.

The first of these properties, the chemical, has been extensively applied ever since its laws were discovered by Faraday. When a current of electricity passes through an electrolytic cell containing the salt of a metal in solution, it carries metal with it to the cathode (i.e., the plate by which it leaves the liquid), and deposits it there. The weight of metal thus deposited is proportional to the number of coulombs that have passed through the cell, and, in order to determine the number, it is sufficient that one of the plates be removed from the cell, weighed, and the difference in weight, the amount it has gained or lost, divided by the number representing the weight of metal which an ampere in a second would deposit from the solution contained in the cell.

This method is so beautifully simple, and so easily applied in any direct system of supply, that a superficial view would suggest its immediate adoption. If we study the method closely, however, with the view of applying it to our purpose, we find in the electrolytic cell inherent weaknesses which are apt to become quite important sources of error when the cell is left to itself for any considerable length of time. Non-uniformity in density of solution employed, foreign substances present in the material of the plates, variations of temperature, are some of the causes interfering with the reliability of the method. If we consider, also, that the consumer is unable to inform himself regarding the progress of his supply by inspecting his meter, and the necessity which exists for taking the meter apart in order to discover it, we will probably concede the possession by the electrolytic cell of many features undesirable in a meter.

The magnetic property of the electric current is apparently the one of which the greatest number of inventors have availed themselves, and which they have applied in the construction of meters. Often, when this method is applied, the meter takes the form of an electric motor having a revolving armature and fitted with some brake device which absorbs the work of the

motor in such a way as to make its rate of movement proportional to the current strength. For example, if the force acting on the armature is proportional to the square of the current, in order that the motor may rotate with twice the velocity when the strength of the current is doubled, it is necessary that the square of the rotations measure the brake force against which the motor is doing work; then the square of the number of rotations in a given time is a measure of the square of the electric current. Therefore, the rate of rotation measures the strength of the current and the number of rotations its quantity.

A form of electric motor, in the adaptation of which to use as an electricity meter, much thought and labour has been expended by inventors, is that depending for its action on the electro-magnetic rotation of mercury. When mercury (or other conductor) is traversed by radial currents (*i.e.*, currents which enter at the centre and leave at the outside, or *vice versa*) and is at the same time acted upon by a magnetic field, the lines of induction in which act in a direction perpendicular to the surface of the mercury, it will rotate in a direction perpendicular to the lines of force and to the direction of flow of the current. Reversing the field changes the direction of rotation, but if at the same time the direction of flow of the current be changed, the direction of rotation will remain as before. The rotative force is said to vary as the square of the current, and the speed as the square root of rotative force. Liquid friction, therefore, in this case supplies the necessary controlling force. We see, therefore, that such a meter should be applicable to both systems of supply. With one notable exception, however (which will be mentioned later), inventors would seem to have met but scant measure of success in the adaptation of this form of motor meter.

In another application the meter takes the form of a machine driven by a constant force and controlled by a force which is also constant so long as no current passes through the conductor. Immediately when the current passes, however, the controlling force is modified, and the velocity of the machine accelerated by a quantity determined by and proportional to the rate of consumption. The acceleration thus becomes a measure of the consumption.

The heating effect of the electric current has received much attention, and many applications have been made of it to the work of electricity meterage since alternating current supply systems became prominent. When a current of electricity passes through a conductor, resistance is encountered and heat is generated, as shown by Joule, at a rate represented by the resistance multiplied by the square of the current. The heating effect being practically the same with alternating and with direct currents, its application seemed to promise a meter equally applicable in both systems of supply, which would approach the electrolytic method in its simplicity, and share at least one important advantage of the magnetic method, inasmuch as it might readily be made to register on dials. Numerous novel and beautiful applications of the heating property of an electric current have been made by Prof. Elihu Thomson to meters, giving their indications by the expansion of gases, by the evaporation, under special conditions, of various liquids, and in other ways.

The ordinary compound bar formed from two strips of material, generally metals possessing different coefficients of expansion and firmly attached to each other throughout their length, may also, in certain combinations, be applied to metering purposes. If one end of such a bar be fixed, and the other end left free to move under the influence of heat, the free end will be deflected through a distance which will be greater or less according as the heat producing the deflection is greater or less. If an inking stylus be attached to the free end of such a bar, and a cylinder or circular dial carrying a properly lined chart revolved at a constant speed in such relation to the bar that the stylus bears lightly against the surface of the chart, heat developed in the bar will cause it to be deflected and the stylus will trace a line on the chart at a greater or less distance from the

zero point, according as the flow of current heating the bar is greater or less. It is apparent, however, that an ordinary compound bar being a simple temperature-measuring device will have motions of its own, independent of the current effect, produced by variations of temperature in the surrounding atmosphere. Errors due to this cause must be avoided. Profs. Geyer and Bristol, in a meter invented by them and constructed on the above plan, avoid this source of error by substituting for the common bar its equivalent made from two pieces of the same material, to one of which is given a radiating surface very much greater than that possessed by the other one. These pieces are firmly secured together, but insulated from each other throughout the greater portion of their length, and are traversed in series by the current which it is desired to measure.

The meter of Prof. E. W. Rice is an integrating or recording meter, and in its construction the arrangement of the compound bars at once eliminates all danger of errors arising from changes of external temperature. In its arrangement two bars are used, which are secured a short distance apart, their free ends being yoked together. The construction of the bars is such that a very slight development of heat is sufficient to effect a considerable displacement of the free ends. Heat is developed in the bars alternately, one only being in the circuit at any time. A slow vibration of the bars results, and within certain limits the rate of vibration can be made to measure to a close approximation the rate of flow of current, which is registered on a common counter in the usual manner.

Another method is that applied by Prof. Forbes. The current to be measured is passed through a conductor placed under a glass or metal cover. When the conductor becomes heated, connection currents circulate in the air in which the conductor is immersed, and these currents are made to expend a portion of their energy in driving a mechanism which effects the registry.

We will now briefly consider a few of the meters which have met with more or less extensive application in practical work. A meter which has been much noticed of late is that known as the Aron meter. This meter is a development of the clock ergometer proposed by Profs. Ayrton and Perry many years ago. Its operation depends on the fact that, within certain limits, the rate of vibration of a pendulum increases with the square roots of the forces attracting it. In one form of this instrument a permanent steel magnet forms the pendulum bob, and immediately underneath, secured to the base of the instrument, is placed a coil of wire, through which the whole of the current to be measured is passed. In the meter case are placed two clock movements; one drives an ordinary pendulum, the other drives the pendulum carrying the magnet; the acceleration of the latter, due to increase of the attracting force acting on the magnet when current is passing in the coil is, by means of differential gearing connecting the two clock movements, indicated upon dials, which are read by the aid of a constant experimentally determined for each instrument. This arrangement constitutes a coulomb meter.

The arrangement originally proposed by Profs. Ayrton and Perry (who seem quite early to have recognised the importance of the meter question) was that of an energy meter, the pendulum bob being a fine wire coil of high resistance connected in shunt across the installation. The latest form of the Aron meter, one which is applicable to the meterage of both alternating and direct systems of supply, is constructed according to their method, the bob being a coil of thin wire attached to the end of the pendulum rod and encircled by the horizontally placed current coil. An interesting feature of this meter is the differential gearing. Two wheels, each about one and a quarter inches in diameter, and having two sets of teeth, being at once spur wheels and crown wheels, are placed about half an inch apart and driven in opposite directions on the same axis, one by each of the clocks. The cylindrical (or crown) gears are placed opposite each other, and a small planet wheel, free at the same time to turn on its own axis

and to roll around that of the cylindrical gears, is arranged between the latter, engaging both. Evidently if the velocity of the two wheels is equal and opposite, the planet wheel will simply be turned on its own centre, but if one of the wheels be driven at a greater velocity than the other, then the planet wheel will suffer a displacement, and will be carried round bodily in the direction and rotation of the wheel having the greater velocity, and this displacement being recorded indicates the consumption. When carefully placed in position, and delicately adjusted, this meter operates satisfactorily, and is sufficiently accurate. It is, however, large, and as yet costly, and it also requires that the clock springs be wound up about once a month.

The meter constructed by Prof. Forbes and introduced by him some two years ago is a beautiful instrument, sufficiently economical and capable of metering alternating and direct currents with equal accuracy. It would, therefore, seem to possess the qualities necessary to secure it a wide application in practical work. It does not appear, however, to have been applied to any extent in the United States. This meter depends for its action on the air currents created by the heat developed in a spirally arranged conductor attached to the base of the instrument; the resistance is said to be about one-hundredth of an ohm. Pivoted above this conductor is a light paper cone having a small pinion attached at the apex and a ring of thin mica at the base. Around the periphery of this ring are fixed eight small cylinders of pith, each carrying a light mica vane inclined at an angle of about 45 degrees to the mica ring. Inside the pinion at the top is a ruby jewel, which rests on a needle point supported upon and rising from the base of the instrument. When current passes through the conductor the convection currents rising impinge on the vanes and cause the cone to revolve (at a rate which Prof. Forbes succeeded in making almost exactly proportional to the current passing through the conductor) and to drive the counter which registers the number of revolutions. The revolving part of this meter is exceedingly light, and when the recording train is carefully constructed, the friction, it is claimed, is relatively small, even when the current is only one-twentieth of the meter's rated capacity. This instrument, is, of course, a quantity or coulomb meter.

The meter of Mr. Shallenberger is essentially an alternating current quantity, or coulomb meter. The construction of the meter is about as follows:

A coil of copper wire of oblong shape, placed horizontally, and traversed by the whole of the current to be measured, constitutes what may be called a primary or inducing circuit. Secured in the interior of this coil are a number of bare copper punchings, which, together, form a closed secondary circuit, and become the seat of induced currents. The planes of the primary and secondary coils cross each other at an angle of about 45 degrees. Inside the secondary closed coil, and closely embraced by it, is a thin ring of soft iron, secured on a light steel shaft, which is pivoted vertically, and free to rotate. The pulses of current, alternating in direction, and flowing through the outer coil to the lamps, induce secondary currents in the closed conductor, and also at the same time polarise the iron ring. Assuming these poles to be formed along the magnetic axis of the coil creating them, they will immediately be attracted toward the field of the closed secondary circuit, situated at an angular distance of about 45 degrees. Thus the pivoted iron being free to rotate, a motive force is created, which is within the range of the instrument approximately proportional to the square of the current. The controlling force in this meter is afforded by air friction, which opposes the motion of a four-winged fan, secured to the shaft carrying the iron ring. It is evident the indications of this meter must be affected by barometric and temperature changes, and also, to some small degree, by changes in the rate of alternations. The former effect would probably be specially noticeable if meters calibrated at sea level were used at varying heights above sea level. These

meters are made of 20 and 40 ampère capacity, and a large number are said to be in use.

The meter of Mr. Ferranti, though almost unknown in the United States, is said to be extensively employed in England in connection with the supply system of that inventor. This is a kind of motor meter, having a magnetic circuit which suggests that of Dr. Hopkinson's Manchester dynamo, the top pole piece, however, being prolonged downward, and wound with a few turns of copper conductor, around which the current is led to the mercury, which it traverses radially. The mercury being placed in a gap in the magnetic circuit, and crossed by lines of force, rotates, carrying a small paddle around with it. A small pinion fixed on a slender shaft rising from the paddle, drives a carefully jewelled train of wheel-work which registers the revolutions. Long range is one of the points aimed at in this meter, and the iron used in its construction (which is laminated) being necessarily but slightly magnetised, the driving force developed by small currents is feeble, thus making the internal friction of the machine relatively important.

Prof. Elihu Thomson early realised the importance assumed by internal friction in meters dynamical in their action, and devised a method by which errors due to it could be made vanishingly small without making extreme delicacy of construction necessary; this he accomplished by supplying to the meter subsidiary energy by means of a shunt or special winding, for instance, sufficient to create a force equal to that opposed by friction and inertia. Since that time the method has been applied by others. Mr. Ferranti winds on his meter magnet a high resistance shunt coil in addition to the conductor carrying the current measured. Arranged in this way a 50-ampère meter is said to start with less than one ampère, a range and a delicacy which are certainly remarkable in an instrument of its class.

An exceedingly interesting application of the electrolytic method to the metering of alternating currents has been made by the English firm of Lowrie, Hall and Co. In applying their method the inventors include in the secondary circuit of the transformer an electrolytic cell containing a saturated solution of copper sulphate in distilled water. The copper plates employed in the cell expose a surface of four square inches per ampère with maximum load. In the same box with the deposition cell is placed an accumulator cell, and the entire current supplied to the lamps is passed through these two cells in series. The effect of this arrangement is to introduce an electromotive force of constant direction into the circuit which adds itself to the alternating electromotive force during the half period when it is in the same direction, and subtracts itself during the half period when it is in the opposite direction. If, for instance, the alternating electromotive force equals 100 volts, and the constant electromotive force of the accumulator cell is two volts, then in the one direction there is acting an electromotive force of 102 volts, and in the other direction, an electromotive force of 98 volts. The volume of current, therefore, flowing in one direction during a half period is greater than that flowing during the other half period by a quantity equal to four volts divided by a resistance which is determined by the number of lamps in circuit. This quantity of current is available, therefore, to make a record in an electrolytic cell. This system does not suggest itself as a very practical one, but is, however, exceedingly interesting from the fact of its being the only application of the electrolytic method to the commercial meterage of alternating currents.

In this article it has merely been attempted to describe a few types of meter in common use. A very large number, however, have been invented and from time to time introduced. Reference, however, to the work of each inventor is more than can be attempted in any single article on the subject. And still the work goes on, no existing electricity meter satisfying all requirements so fully as to render its use completely satisfactory.

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 650.)

## ELECTRO-MAGNETS FOR MAXIMUM TRACTION.

These have already been dealt with in the preceding lecture; the characteristic feature of all the forms suitable for traction being the compact magnetic circuit.

Several times it has been proposed to increase the power of electro-magnets by constructing them with intermediate masses of iron between the central core and the outside, between the layers of windings. All these constructions are founded on fallacies. Such iron is far better placed either right inside the coils or right outside them, so that it may properly constitute a part of the magnetic circuit. The constructions known as Camacho's and Cance's, and one patented by Mr. S. A. Varley in 1877, belonging to this delusive order of ideas, are now entirely obsolete.

Another construction which is periodically brought forward as a novelty is the use of iron windings of wire or strip in place of copper winding. The lower electric conductivity of iron, as compared with copper, makes such a construction wasteful of exciting power. To apply equal magnetising power by means of an iron coil implies the expenditure of about six times as many watts as need be expended if the coil is of copper.

## ELECTRO-MAGNETS FOR MAXIMUM RANGE OF ATTRACTION.

We have already laid down the principle which will enable us to design electro-magnets to act at a distance. We want our magnet to project, as it were, its force across the greatest length of air gap. Clearly, then, such a magnet must have a very large magnetising power, with many ampère turns upon it, to be able to make the required number of magnetic lines pass across the air resistance. Also it is clear that the poles must not be too close together for its work, otherwise the magnetic lines at one pole will be likely to curl round and take short cuts to the other pole. There must be a wider width between the poles than is desirable in electro-magnets for traction.

## ELECTRO-MAGNETS OF MINIMUM WEIGHT.

In designing an apparatus to put on board a boat or a balloon, where weight is a consideration of primary importance, there is again a difference. There are three things that come into play—iron, copper, and electric current. The current weighs nothing, therefore, if you are going to sacrifice everything else to weight, you may have comparatively little iron, but you must have enough copper to be able to carry the electric current; and under such circumstances you must not mind heating your wires nearly red hot to pass the biggest possible current. Provide as little copper as you conveniently can, sacrificing economy in that case to the attainment of your object; but of course you must use fire-proof material, such as asbestos, for insulating, instead of cotton or silk.

## A USEFUL GUIDING PRINCIPLE.

In all cases of design there is one leading principle which will be found of great assistance, namely, that a magnet always tends so to act as though it tried to diminish the length of its magnetic circuit. It tries to grow more compact. This is the reverse of that which holds good with an electric current. The electric circuit always tries to enlarge itself, so as to enclose as much space as possible, but the magnetic circuit always tries to make itself as compact as possible. Armatures are drawn in, as near as can be, to close up the magnetic circuit. Many two-pole electro-magnets show a tendency to bend together when the current is turned on. One form in particular, which was devised by Ruhmkorff for the purpose of repeating Faraday's celebrated experiment on the magnetic rotation of polarized light, is liable to this defect. Indeed, this form of electro-magnet is often designed very badly, the yoke being too thin, both mechanically and magnetically, for the purpose which it has to fulfil.

Here is a small electric bell, constructed by Wagener of Wiesbaden, the construction of which illustrates this principle. The electro-magnet, a horseshoe, lies horizontally; its poles are provided with protruding curved pins of brass. Through the armature are drilled two holes, so that it can be hung upon the two brass pins; and when so hung up it touches the ends of the iron cores just at edge, being held from more perfect contact by a spring. There is no complete gap, therefore, in the magnetic circuit. When the current comes and applies a magnetizing power it finds the magnetic circuit already complete in the sense that there are no absolute gaps. But the circuit can be bettered by tilting the armature to bring it flat against the polar ends, that being indeed the mode of motion. This is a most reliable and sensitive pattern of bell.

*Electro-magnetic Pop-gun.*—Here is another curious illustration of the tendency to complete the magnetic circuit. Here is a tubular electro-magnet (fig. 53), consisting of a small bobbin, the core of which is an iron tube about two inches long. There is nothing very unusual about it; it will stick on, as you see, to pieces of iron when the current is turned on. It clearly is an

ordinary electro-magnet in that respect. Now suppose I take a little round rod of iron, about an inch long, and put it into the end of the tube, what will happen when I turn on my current? In this apparatus as it stands, the magnetic circuit consists of a short length of iron, and then all the rest is air. The magnetic circuit will try to complete itself, not by shortening the iron, but by lengthening it; by pushing the piece of iron out so as to afford more surface for leakage. That is exactly what happens; for, as you see, when I turn on the current the little piece of iron shoots out and drops down. You see that little piece of iron shoot out with considerable force. It becomes a sort of magnetic pop-gun. This is an experiment which has been twice discovered. I found it first described by Count Du Moncel, in the pages of *La Lumière Electrique*, under the name of the "pistolet électromagnétique;" and Mr. Shelford Bidwell invented it independently. I am indebted to him for the use of this apparatus. He gave an account of it to the Physical Society, in 1885, but the reporter missed it. I suppose, as there is no record in the Society's proceedings.

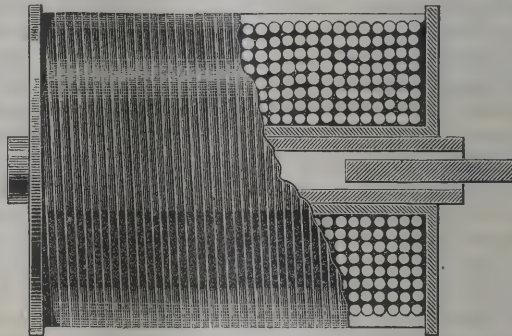


FIG. 53.—ELECTRO-MAGNETIC POP-GUN.

## ELECTRO-MAGNETS FOR USE WITH ALTERNATING CURRENTS.

When you are designing electro-magnets for use with alternating currents, it is necessary to make a change in one respect, namely, you must so laminate the iron that internally eddy currents shall not occur; indeed, for all rapid acting electro-magnetic apparatus it is a good rule that the iron must not be solid. It is not usual with telegraphic instruments to laminate them by making up the core of bundles of iron plates or wires, but they are often made with tubular cores, that is to say, the cylindrical iron core is drilled with a hole down the middle, and the tube so formed is slit with a saw-cut to prevent the circulation of currents in the stance of the tube. Now when electro-magnets are to be employed with rapidly alternating currents, such as are used for electric lighting, the frequency of the alternations being usually about 100 periods per second, slitting the cores is insufficient to guard against eddy-currents; nothing short of completely laminating the cores is a satisfactory remedy. I have here, thanks to the Brush Electric Engineering Company, an electro-magnet of the special form that is used in the Brush arc lamp when required for the purpose of working in an alternating current circuit. It has two bobbins that are screwed up against the top of an iron box at the head of the lamp. The iron slab serves as a kind of yoke to carry the magnetism across the top. There are no fixed cores in the bobbins, which are entered by the ends of a pair of yoked plungers. Now in the ordinary brush lamp for use with a steady current, the plungers are simply two round pieces of iron tapped into a common yoke; but for alternate current working this construction must not be used, and instead a U-shaped double plunger is used, made up of laminated iron, riveted together. Of course it is no novelty to use a laminated core; that device, first used by Joule, and then by Cowper, has been re-patented rather too often during the past fifty years to be considered as a recent invention.

The alternate rapid reversals of the magnetism in the magnetic field of an electro-magnet, when excited by alternating electric currents, sets up eddy-currents in every piece of undivided metal within range. All frames, bobbin tubes, bobbin ends, and the like, must be most carefully slit, otherwise they will overheat. If a domestic flat-iron is placed on the top of the poles of a properly laminated electro-magnet, supplied with alternating currents, the flat-iron is speedily heated up by the eddy-currents that are generated internally within it. The eddy-currents set up by induction in neighbouring masses of metal, especially in good conducting metals such as copper, give rise to many curious phenomena. For example, a copper disc or copper ring placed over the pole of a straight electro-magnet so excited is violently repelled. These remarkable phenomena have been recently investigated by Professor Elihu Thomson, with whose beautiful and elaborate researches we have lately been made conversant in the pages of the technical journals. He rightly attributes many of the repulsion phenomena to the lag in phase of the alternating currents thus induced in the conducting metal. The electro-magnetic inertia, or self-inductive property of the electric circuit, causes the currents to rise and fall later in time than the electromotive forces by which they are occasioned. In all such cases the impedance which the circuit offers is made up of two things—resistance and inductance. Both these causes tend to diminish the amount of current that flows, and the inductance also tends to delay the flow.

\* Cantor Lecture. Delivered before the Society of Arts, February 3rd, 1890.

## ELECTRO-MAGNETS FOR QUICKEST ACTION.

I have already mentioned Hughes's researches on the form of electro-magnet best adapted for rapid signalling. I have also incidentally mentioned the fact that where rapidly varying currents are employed, the strength of the electric current that a given battery can yield is determined not so much by the resistance of the electric circuit, as by its electric inertia. It is not a very easy task to explain precisely what happens to an electric circuit when the current is turned on suddenly. The current does not suddenly rise to its full value, being retarded by inertia. The ordinary law of Ohm in its simple form no longer applies; one needs to apply that other law which bears the name of the law of Helmholtz, the use of which is to give us an expression, not for the final value of the current, but for its value at any short time,  $t$ , after the current has been turned on. The strength of the current after a lapse of a short time,  $t$ , cannot be calculated by the simple process of taking the electromotive force and dividing it by the resistance, as you would calculate steady currents.

In symbols, Helmholtz's law is:—

$$i_t = \frac{E}{R} \left( 1 - e^{-\frac{R}{L}t} \right).$$

In this formula  $i_t$  means the strength of the current after the lapse of a short time  $t$ ;  $E$  is the electromotive force;  $R$  the resistance of the whole circuit;  $L$  its co-efficient of self-induction; and  $e$  the number 2.7183, which is the base of the Napierian logarithms. Let us look at this formula; in its general form it resembles Ohm's law, but with a new factor, namely, the expression contained within the brackets. This factor is necessarily a fractional quantity, for it consists of unity less a certain negative exponential, which we will presently further consider. If the factor within brackets is a quantity less than unity, that signifies that  $i_t$  will be less than  $E \div R$ . Now the exponential of negative sign, and with negative fractional index, is rather a troublesome thing to deal with in a popular lecture. Our best way is to calculate some values, and then plot it out as a curve. When once you have got it into the form of a curve, you can begin to think about it, for the curve gives you a mental picture of the facts that the long formula expresses in the abstract. Accordingly we will take the following case. Let  $E = 2$  volts;  $R = 1$  ohm; and let us take a relatively large self-induction, so as to exaggerate the effect; say let  $L = 10$  quads. This gives us the following:—

$t$ (sec.)	$e^{-\frac{R}{L}t}$	$i_t$
0	1	0
1	1.105	0.950
2	1.221	1.810
5	1.649	3.936
10	2.718	6.343
20	7.389	8.646
30	20.08	9.501
60	403.4	9.975
120	162800.0	9.999

In this case the value of the steady current, as calculated by Ohm's law, is 10 amperes; but Helmholtz's law shows us that with the great self-induction, which we have assumed to be present, the current, even at the end of 30 seconds, has only risen up to within 5 per cent. of its final value; and only at the end of two minutes has practically attained full strength. These values are set out in the highest curve in fig. 54, in which, however, the

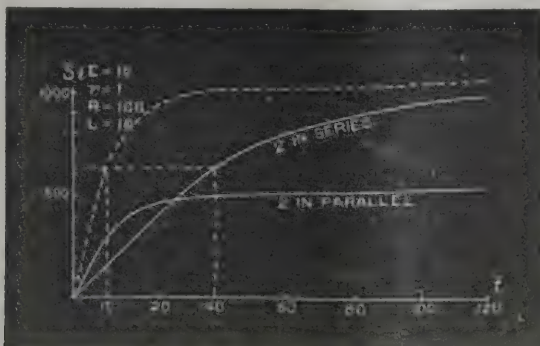


FIG. 54.—CURVES OF RISE OF CURRENTS.

further supposition is made that the number of spirals,  $s$ , in the coils of the electro-magnet is 100, so that when the current attains its full value of 10 amperes, the full magnetising power will be  $s i = 1,000$ . It will be noticed that the curve rises from zero at first steeply and nearly in a straight line, then bends over, and then becomes nearly straight again, as it gradually rises to its limiting value. The first part of the curve—that relating to the strength of the current after very small interval or time—is the period within which the strength of the

current is governed by inertia (*i.e.*, the self-induction) rather than by resistance. In reality the current is not governed either by the self-induction or by the resistance alone, but by the ratio of the two. This ratio is sometimes called the "time constant" of the circuit, for it represents the time which the current takes in that circuit to rise to a definite fraction of its final value. This

definite fraction is the fraction  $\frac{e-1}{e}$ ; or in decimals, 0.634. All

curves of rise of current are alike in general shape—they differ only in scale; that is to say, they differ only in the height to which they will ultimately rise, and in the time they will take to attain this fraction of their final value.

Example (1).—Suppose  $E = 10$ ;  $R = 200$  ohms;  $L = 8$ . The final value of the current will be 0.025 amp. or 25 milliamperes. Then the time constant will be  $8 \div 400 = \frac{1}{50}$ th sec.

Example (2).—The P.O. Standard "A" relay has  $R = 400$  ohms;  $L = 3.25$ . It works with 0.5 milliamperé current, and therefore will work with 5 Daniell cells through a line of 9,600 ohms. Under these circumstances the time constant of the instrument on short circuit is 0.0081 sec.

It will be noted that the time constant of a circuit can be reduced either by diminishing the self-induction or by increasing the resistance. In fig. 54 the position of the time constant for the top curve is shown by the vertical dotted line at 10 seconds. The current will take 10 seconds to rise to 0.634 of its final value. This retardation of the rise of current is simply due to the presence of coils and electro-magnets in the circuit; the current as it grows being retarded because it has to create magnetic fields in these coils, and so sets up opposing electromotive forces that prevent it from growing all at once to its full strength. Many electricians, unacquainted with Helmholtz's law, have been in the habit of accounting for this by saying that there is a lag in the iron of the electro-magnet cores. They tell you that an iron core cannot be magnetised suddenly; that it takes time to acquire its magnetism. They think it is one of the properties of iron. But we know that the only true time lag in the magnetisation of iron—that which is properly termed "viscous hysteresis"—does not amount to any great percentage of the whole amount of magnetisation, takes comparatively a long time to show itself, and cannot therefore be the cause of the retardation which we are considering. There are also electricians who will tell you that when magnetisation is suddenly evoked in an iron bar, there are induction currents set up in the iron which oppose and delay its magnetisation. That they oppose the magnetisation is perfectly true; but if you carefully laminate the iron so as to eliminate eddy currents, you will find, strangely enough, that the magnetism rises still more slowly to its final value. For by laminating the iron you have virtually increased the self-inductive action, and increased the time-constant of the circuit, so that the currents rise more slowly than before. The lag is not in the iron, but in the magnetising current, and the current being retarded, the magnetisation is, of course, retarded also.

## CONNECTING COILS FOR QUICKEST ACTION.

Now let us apply these most important, though rather intricate considerations to the practical problems of the quick working of the electro-magnet. Take the case of an electro-magnet forming some part of the receiving apparatus of a telegraph system, in which it is desired to secure very rapid working. Suppose the two coils that are wound upon the horseshoe core are connected together in series. The coefficient of self-induction for these two is four times as great as that of either separately; coefficients of self-induction being proportional to the square of the number of turns of wire that surround a given core. Now if the two coils, instead of being put in series, are put in parallel, the coefficient of self-induction will be reduced to the same value as if there were only one coil, because half the line current (which is practically unaltered) will go through each coil. Hence the time constant of the circuit when the coils are in parallel will be a quarter of that which it is when the coils are in series; on the other hand, for a given line current, the final magnetising power of the two coils in parallel is only half what it would be with the coil in series. The two lower curves in fig. 54 illustrate this, from which it is at once plain that the magnetising power for very brief currents is greater when the two coils are put in parallel with one another than when they are joined in series.

Now this circumstance has been known for some time to telegraph engineers. It has been patented several times over. It has formed the theme of scientific papers, which have been read both in France and in England. The explanation generally given of the advantage of uniting the coils in parallel is, I think, fallacious; namely that the "extra currents" (*i.e.*, currents due to self-induction), set up in the two coils are induced in such directions as tend to help one another when the coils are in series, and to neutralise one another when they are in parallel. It is a fallacy, because in neither case do they neutralise one another. Whichever way the current flows to make the magnetism, it is opposed in the coils while the current is rising, and helped in the coils while the current is falling, by the so-called extra currents. If the current is rising in both coils at the same moment, then whether the coils are in series or in parallel, the effect of self-induction is to retard the rise of the current. The advantage of parallel grouping is simply that it reduces the time-constant.

## BATTERY GROUPING FOR QUICKEST ACTION.

One may consider the question of grouping the battery cells from the same point of view. How does the need for rapid working, and the question of time-constant, affect the best mode of

grouping the battery cells? The amateur's rule, which tells you to so arrange your battery that its internal resistance should be equal to the external resistance, gives you a result wholly wrong for rapid working. The supposed best arrangement will not give you (at the expense even of economy) the best result that might be got out of the given number of cells. Let us take an example and calculate it out, and place the results graphically before our eyes in the form of curves. Suppose the line and electro-magnet have together a resistance of 6 ohms, and that we have 24 small Daniell's cells, each of electromotive force, say, 1 volt, and of internal resistance, 4 ohms. Also let the coefficient of self-induction of the electromagnet and circuit be 6 quadrants. When all the cells are in series the resistance of the battery will be 96 ohms, the total resistance of the circuit 102 ohms, and the full value of the current 0.235 ampère. When all the cells are in parallel the resistance of the battery will be 0.133 ohm, the total resistance 6.133 ohms, and the full value of the current 0.162 ampère. According to the amateur rule of grouping cells so that internal resistance equals external, we must arrange the cells in four parallels, each having six cells in series, so that the internal resistance of the battery will be six ohms, total resistance of circuit 12 ohms, full value of current 0.5 ampère. Now the corresponding time-constants of the circuit in the three cases (calculated by dividing the co-efficient of self-induction by the total resistance) will be respectively—in series, 0.06 sec.; in parallel, 0.5 sec.; grouped for maximum steady current, 0.96 sec. From these data we may now draw the three curves, as in fig. 55, wherein the abscissæ are

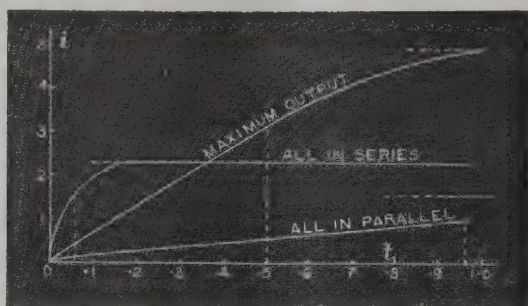


FIG. 55.—CURVES OF RISE OF CURRENT WITH DIFFERENT GROUPINGS OF BATTERY.

the values of time in seconds, and the ordinates the current. The faint vertical dotted lines mark the time-constants in the three cases. It will be seen that when rapid working is required the magnetising current will rise, during short intervals of time, more rapidly if all the cells are put in series than it will do if the cells are grouped according to the amateur rule.

When they are all put in series, so that the battery has a much greater resistance than the rest of the circuit, the current rises much more rapidly, because of the smallness of the time constant, although it never attains the same ultimate maximum as when grouped in the other way. That is to say, if there is self-induction as well as resistance in the circuit, the amateur rule does not tell you the best way of arranging the battery. There is another mode of regarding the matter which is helpful. Self-induction, while the current is growing, acts as if there were a sort of spurious addition to the resistance of the circuit; and while the current is dying away it acts of course in the other way, as if there were a subtraction from the resistance. Therefore you ought to arrange the battery so that the internal resistance is equal to the real resistance of the circuit, plus the spurious resistance during that time. But how much is the spurious resistance during that time? It is a resistance proportional to the time that has elapsed since the current was turned on. So then it comes to a question of the length of time for which you want to work it. What fraction of a second do you require your signal to be given in? What is the rate of the vibrator of your electric bell? Suppose you have settled that point, and that the short time during which the current is required to rise is called  $t$ ; then the apparent resistance at time after the current is turned on is given by the formula:—

$$R_t = R \times e^{\frac{R}{L}t} + \left( \frac{R}{L} - 1 \right).$$

(To be continued.)

## THE ELECTRIC LIGHT IN ITS RELATION TO THE CONSUMER.\*

By C. W. NAYLOR.

THE electric light is a broad subject for either study or discussion. It can be looked at from many directions. It is a theme for both the scientist and general student.

The mechanic or engineer who starts out intending to design

\* Read October 25th, before Illinois Branch No. 28, National Association of Stationary Engineers.

or build electric machinery and appliances, maps out for himself a life-long course of study. To the speculative business man who makes and sells the electric light as a commercial product, it has an intense interest. The investor in central station apparatus takes a peculiarly pecuniary view of the electric light.

Still another class finds itself compelled by circumstances to investigate the subject of electric lighting. This class is composed of the consumers. The consumer is forced to consider it. His reflections lead him rapidly to conclusions. It is a powerful and easily controlled means of illumination, capable of regulation at will, it can be extinguished or relighted at pleasure, and instantaneously; it can be moved and removed from place to place. It is, moreover, a safe light—safe in the insurance or fire risk sense. It is not so expensive that it can be classed among the luxuries. It must, perforce, be admitted that the electric light is a plain every day matter of fact illuminant, and, as a practical thing, has come to stay with us. As such, it is to be gauged and measured by that worldly standard—the almighty dollar.

The question is, "Does it pay?" The answer involves an intricate problem.

What does it cost to make the electric light? To anticipate somewhat, it will be found that it is proportionately cheaper to generate it on a large scale. This fact is not surprising, for it holds true in the operation of most commercial apparatus.

For very small generating plants, the costs as compared with those of medium-sized or large stations are utterly disproportionate. To operate a few lamps only, by means of machinery, would be many times more expensive than any of the other ordinary means of lighting.

It will not be necessary here to claim everything for the electric light and insist that it is a necessity, and that everybody must sooner or later adopt it. It will be only a matter of a few years at most when the claim will make itself good.

There is no necessity that the advocate of electric lights should lose his composure or worry over the seeming slowness of men to appreciate this great boon to the commercial world.

In a very short time—we shall live to see the day—the electric light will reign supreme where people live thickly congregated and depend for existence upon their industry. As present users enlarge their plants, as new converts augment the demand for it, production will be cheapened, and thereby its field of usefulness will be increased.

How much will it cost to put in and operate an electric light equipment?

Assume for the time being that there is no machinery in an establishment, and that it becomes necessary to rent lights, the place in question being a small store or salesroom. The charge for one arc lamp to burn all day, say for 10 hours, will be 50 cents per day. This can be compared with the price that would be paid for gas light. Assume as a basis of comparison 10 gas jets. This comparison, however, is hardly fair to the electric light, as the illumination given by the latter is vastly superior to that of the gas.

Ten gas jets at an average consumption of 5 cubic feet of gas per hour per burner, at \$1.25 per 1,000 feet will cost for 10 hours, 62½ cents. The electric light, as will be readily seen, is much the cheaper, is more powerful and penetrating, is cleaner, and vastly safer, so far as fire risk is concerned. It is switched on at once and off again just as quickly; it does not overheat the room: it will not ruin ceilings and walls with soot and grease, nor damage fabrics with deleterious, sulphurous and other gases. Gas cannot be obtained at a price much cheaper than that mentioned. Even at \$1 per 1,000, the cost figured as before will reach 50 cents per day, which is fully as expensive as the electric arc.

This is the limit of economy in gas lighting. Should it become desirable to light a large room or a number of rooms gas cannot be had cheaper. On the other hand, electric lights are rated by a graded price list. If 5, or 10, or 20 electric lights are needed, they are to be had for 40 cents each per day, which is 20 per cent. less than the charge for gas. In fact, they can be contracted for at the low rate of 33 cents per day, almost 40 per cent. cheaper than the gas method of lighting. Gas light varies with the season and output, now weak, now strong. Sometimes it can hardly be coaxed out of the burners, at other times it flames to the ceiling. Now it is yellow and now red; it is very often blue, but very seldom white. In winter so sluggish is it that it is with difficulty cajoled into leaving its natural lair under the ground.

The electric light assures to the consumer at all times the full measure of an almost perfect illumination. With all its drawbacks it is wonderfully superior to any and all other known means of artificial lighting. There are numerous objections to the use of this light, most of them, however, are trivial.

Considering it from the dollar and cents point, to which we shall endeavour to confine ourselves, there arises the apparently serious objection that the lights cost whether they are kept burning or not. Gas can be turned on or off, and a saving thereby effected.

There are large commercial houses in this city with spacious and well stocked sales and display rooms that are kept for hours at a stretch in the deepest gloom. When a salesman leads a customer perspective or *bond fide* through the various departments, a boy or porter precedes him turning on the gas and turning it off behind him, as he passes with his buyer.

This is not exaggerated. It is a most ridiculous transaction and cannot possibly be economical. People who are compelled to do this would save money by renting a smaller store and lighting it up as it should be lighted.

All the business done by an establishment of the kind cited above could be transacted in one-fourth of the space at present occupied.

One thousand dollars saved in rent and expended for electric lights or gas would make it possible to do a much larger business, and leave what is very desirable—a good impression on the trade.

To be consistent and follow out the line of policy exhibited in their scheme of lighting the store, these firms should dispense with their engineers and elevators and hire two or three strong labourers, who by patient industry might manage to carry, piece by piece, all their freight up and down stairs, day by day.

The electric light must be used in quantities to be really appreciated. A large business, however, cannot very well get along without it. Experience demonstrates the fact.

Among the firms in this city are scores that pay \$25 or more for this means of lighting. Several expend upward of \$40 or \$50 per day, while one house expends not less than \$100 hard cash each and every week day during the year for electric lights, and is not yet satisfied, but cries for more. It is not used as an advertisement. It is not a luxury, but a practical everyday attachment to the machinery of the establishment.

It will pay, and pay well. It does pay, and is paying. Use electric lights then, even if they must perforce be rented; but they are a much more profitable investment where the machines for generating the current are operated by the persons who are to use them.

The two principal items of expense going to make up the total cost of electric arc lights are fuel and labour. These two items constitute from 75 per cent. to 90 per cent. of all expense connected therewith. The cost of labour, which alone may amount to 50 per cent., 60 per cent., or even 80 per cent., of the total expense is the great stumbling-block in the way of operating a small plant. It is the only thing that requires special consideration when it has been decided to erect an outfit for operating fewer than 20 or 30 lights—of course circumstances have everything to do with the case and must be taken into account. For instance, a firm may have an engineer and a boy or young man with but little to do. These two together could operate a plant of 10, 20, or 30 lights at a minimum cost. The cost, possibly, would be as low as 12 cents or 15 cents per day per lamp, provided, of course, the time of neither the engineer nor the boy was charged to the expense of maintaining the lights. On the other hand, if an establishment has no engineer, no boilers, and no engine, and provides them especially in order that it may operate a plant of 10 lights' capacity, each lamp may cost it 45 cents, 50 cents, or even 60 cents per day, and that for less than 10 hours' run. The cost may reach as high as 75 cents or \$1 for a full day of 10 hours.

These estimates have reference only to the ordinary arc lamp and do not apply at all to the incandescent lamp. The same engineer and assistant whose wages were included in the last estimate, could very easily run 40 or 50 lamps at a cost not to exceed 25 cents, or at most 30 cents daily per light. This last case assumes that the engineer and his assistant have nothing to do but run the lights, and that there are no elevators, no machinery, no heating to attend to. The engineer is assumed to receive \$3 per day and the assistant \$1.50 cents per day. If more is paid for help or less, the running price per lamp will vary about 4 cents or 5 cents per day one way or the other, as the case may be.

The work put upon the operator of a plant of this kind running about 30 lights and not to exceed 40 lights, leaves considerable spare time on the hands of the engineer who can then, with the assistance of a fireman, take care of two or three elevators in addition to their duties as electricians. If so, and this is a very common case, and a fair proportion of their time be charged to elevators and heat, and the other legitimate departments of the regular engineer's work, then the cost of lighting is reduced just that much. The whole process is in harmony with the general proposition that an engineer can care for more machinery and elevators and fewer electric lights, or for a greater number of electric lights and fewer elevators and other machinery. As the proportion of each kind of work varies, so the cost per lamp for operating the electric light will oscillate between 22 or 23 cents as a minimum and 28 or 30 cents as a maximum.

It can be assumed as an axiom in electric lighting that it requires at least 1 horse-power's worth of fuel to operate an arc light. One horse-power may mean 2 lbs. of coal, or it may mean 10 lbs. In general practice it means from 4½ lbs. to 8 lbs. of fuel.

It will be contended that the former figure, 4½ lbs., or at most 5 lbs., is plenty large enough. Experience, however, will show that the coal bill at the end of the month, allowing for waste when starting, or banking fires, when the latter practice is followed, will tally best with a large or medium rate. We will figure, then, on a basis of 6 lbs. of coal, or its equivalent, if a different fuel is used.

Coal costs from \$1.50 to \$5.50 per ton, averaging between \$2.25 or \$2.50 and \$3.25, according to quantity and quality. Assume that it costs \$3 per ton of 2,000 lbs. A difference of 25 cents one way or the other from this price will not seriously affect the general result we are seeking. With 6 lbs. of coal per hour, the amount used in developing 1 horse-power or its equivalent, one arc light, will cost about nine-tenths of a cent per hour, or 8 cents to 9 cents daily for a 10 hours' run.

This estimate of 8 cents per day for fuel for each lamp is the basis upon which to build when estimating for electric lights. This item is fixed and unchangeable except in very small fractions. It is immaterial, practically speaking, whether the plant

is to have 30, 40, 50 or even 100 lamps. The coal consumption per lamp remains virtually constant.

Exclusive of labour all other expenses connected with the operation of an electric light plant can be readily compared with the cost of fuel to which it bears a nearly fixed ratio varying from one-fourth to one-half of the fuel cost, or from 2 to 4 cents, per day per lamp. The average is generally midway between these extremes, and approximating, therefore, to 3 cents daily. It appears now that arc lights are to cost for fuel and other expenses, exclusive of labour and carbons, the sum of 11 cents per day.

To the cost again must be another added fixed charge, that for carbons. Although important, this item is unvarying and to simplify the matter, has been left untouched until this late moment. It is even more rigid in its effect upon the price of lights than coal. Carbons, or carbon pencils, as they are called, do not vary in price over 10 per cent. between any two systems of lighting, nor does the amount consumed per lamp vary much more than 10 per cent. in the different systems, provided the running hours are the same, and a similar general economy is practiced.

Carbons are very cheap now. Six years ago they cost \$40 per 1,000; three years ago \$12 per 1,000; to-day even less than \$10 per 1,000. This great drop in price has effected a wonderful saving in the operation of electric lights.

Not less than one and one-half, and not more than three carbons per day per lamp are used. A very liberal estimate will allow for three carbons per lamp for the ten hours. If these carbons cost over a cent apiece, it is so little over that the fraction may be disregarded. Three cents a day is a very liberal allowance for this item of expense.

Add this to the 11 cents, and there is obtained a grand total of 14 cents per day per lamp as a measure of the operating expense attached to the generation and distribution of the electric arc lamps. It may be said that no risk will be incurred in accepting as accurate these figures of 8 cents for coal, 3 cents for incidentals, and 5 cents for carbons, and using them as standards.

In addition to these fixed values is the cost of labour, a most disturbing and widely varying element of wonderful importance, and demanding careful study. When it can be said that labour varies between one-half and nine-tenths of the total expense, it will be at once perceived how important a fact it is. Sometimes it is as low as one-half, or at least two-thirds of the established 14 cents, and, again, it is as high as five, six, or seven times that amount in proportion as the daily cost per light hovers between 22 cents per day and \$1 per day.

The cost we are now discussing is simply the operating expense connected with generating and distributing the light. No account is here taken of those other important elements which go to make up the total amount expended or tied up in the effort to furnish to the consumer this steady, constant, artificial means of illumination—interest on the plant, depreciation on machinery and buildings, rent, taxes, insurance, accidental expenses, collections, advertising and management, together make up an enormous total, not less in any case than 100 per cent. of the operating expenses, and very often more—so it will be seen that arc lights can not very well be profitably sold for much less than 40 cents per day, although they are furnished by contract for as low as 35 cents, or may be a shade less.

In several cases lights are run for this amount and less, but they cost more. If a small central station makes a practice of furnishing them for so small a sum as 30, 32, or 35 cents, it is simply throwing away money or its equivalent, the valuable time of a manager who must work for next to nothing, and who could, without any serious effort, find much more profitable employment. It does not pay, taking trouble and worry and accident into account.

The investor, in an undertaking of this character, will soon discover that it does not return him dividends at all commensurate with the risk of capital involved.

These small central stations form one of the two classes of electric light furnishers which make lights at an apparently low cost. The other class embraces the public institutions, municipal corporations, and the like.

In a town in New York State, of which you have all probably heard, they claim to run the lamps for 12 cents per day. The city does this at its waterworks station, and does not figure in a cent for labour, rent, interest, taxes, water, management and the like, merely charging for coal and carbons. The labour, it is claimed, costs nothing, as the fireman and engineer are there anyway, and the water departments would have to pay their wages and all other incidental expenses.

Thus these lights cost apparently an insignificant 12 cents daily. It is an absurd calculation to omit in the estimate one of the most important elements.

In Maine there is a city that runs its lights by water power, and forgets to charge up the cost or rental value of that power in making the estimates, bringing the apparent cost of lights down to 16 cents daily.

Here, in Chicago, we have the spectacle of our municipal corporation claiming to furnish lights for 19 cents daily. The absurdity of the claim, and the fallacy of the arguments in support of the claim, were commented upon at the last National Electric Light Convention.

Electric lights are run cheaper in proportion as they are run in large numbers.

Let us take up for study one of the large city plants, and see how nearly the claim of 19 cents daily is borne out by the facts as nearly as we can get at them, and there will be no serious difficulty, for the stations are run wide open, and are public in their

character. Nothing is concealed from the inquisitive searcher for knowledge.

The station in question is fitted up with mechanical stokers under 66-inch steel boilers, with the most approved setting, and is operated under a constant unvarying load. There is probably no greater variation than 10 horse-power, on a total of 500 horse-power from one day to another.

In the station referred to there are 18 dynamos belted direct from single acting automatic cut-off high speed engines, which take steam at 90 lbs. pressure, and exhaust into an improved feed water heater.

Of the 18 dynamos one or two are running idle, being in reserve. They consume very little power, not over 5 or 6 horse-power. The remainder of the dynamos are carrying a load of somewhat less than 450 lights, distributed over 30 or 40 miles of underground circuits.

Between 10 per cent. and 15 per cent. of the power is lost between the dynamo and the boiler which, added to an allowance of one horse-power for each light, gives a total of 520 horse-power being generated and consumed.

A very cheap coal is burned if we are to judge by the appearance and amount of ashes hauled out. Eight pounds per hour per horse-power, considering the style of engine used, would be a very fair measure, but to be doubly sure we will assume seven pounds per hour per horse-power; 520 multiplied by 7, gives 3,640 pounds of coal per hour.

The running time varies from eight hours in summer to fourteen hours in winter, depending upon the length of the night. The averaging is about eleven hours. It requires at least one hour's extra coaling to raise the steam before starting, as full steam must be had from the send-off, all the lights being thrown on within a period of 15 minutes. This makes a total of 12 hours, and 12 times 3,640 pounds, or 43,680 pounds of coal are used per day. At \$2.10 per ton—a very low figure—the cost of coal is \$45.86 daily. Assuming that one pound of coal evaporates seven and one-half gallons of water, there will be used daily, exclusive of water for washing out, cleaning, &c., about 44,000 gallons, which at 8 cents per 1,000 is worth \$3.49. Gas for lighting while lamps are not running comes to 15 or 20 cents daily. Let us call it 15 cents.

Carbons are used at the rate of two and one-half per lamp, or 1,125 daily, which, at \$8.50 per 1,000, cost \$9.56.

Not less than four globes will be required daily at 50 cents each, which makes \$2 per day for this item. Just here the city effects a great saving over the regular central stations and private operators of electric lights. If a globe used indoors cracks or a piece drops out, its usefulness has departed, and it must be at once replaced by a new one. Each renewal means an outlay of 45 or 50 cents. Out of doors on the lofty city poles three-fourths of the life of a globe is still in it after it has become cracked or slightly broken. It may seem strange, but the globe invariably lasts twice as long after a piece has fallen out as before, for the reason, no doubt, that it can expand and contract far more easily under great and sudden changes of temperature.

A careful inspection would show that about 80 per cent. of all globes on the street lamps in Chicago are cracked or broken; in fact, many of them are more hole than glass.

Brushes for the dynamo cost \$1 per day, carbon holders for the lamp cost fully 50 cents per day. Dynamo and lamp repairs, commutator segments and screws, insulating wood, varnish and tape, oil cup glasses, renewals and repairs of tools, emery paper, crocus cloth, pliers, carbon kits, &c., cost not a cent less than \$2 per day.

Cotton waste and wiping rags, gaskets, sheet and piston packings cost \$1 per day at a low estimate.

The amount of lubricating and cylinder oils for engines, dynamos, and pumps will be six gallons daily, which at 50 cents will cost \$3 per day.

The boilers and piping cost \$15,000. The engines and belting cost \$10,000. The dynamos and lamps cost \$18,000; total, \$43,000. Ten per cent. of this for wear and tear, and depreciation and renewals is \$4,300 annually, or \$11.77 daily.

The building cost \$20,000; 5 per cent. for depreciation and renewals is \$1,000 annually, or \$2.75 daily.

The insurance on a total of \$63,000 is not less certainly than \$1 per day. The ground is valued at \$20,000, making a total investment of \$83,000; 4½ per cent. interest on this amount is \$3,735 annually, or \$10.23 daily.

This is a total amount, so far, of \$94.32 daily, made up as follows:—

## COST OF OPERATION.

Coal	...	...	...	...	\$45 86
Water	...	...	...	...	3 49
Gas	...	...	...	...	15
Carbon points	...	...	...	...	9 56
Globes, lamp	...	...	...	...	2 00
Brushes, dynamo	...	...	...	...	1 00
Holders, carbon...	...	...	...	...	50
Incidentals	...	...	...	...	2 00
Waste and packing	...	...	...	...	1 00
Oil	...	...	...	...	3 00
Wear and tear on machinery	...	...	...	...	11 77
Wear and tear on building	...	...	...	...	2 75
Insurance	...	...	...	...	1 00
Interest	...	...	...	...	10 23
<b>Total</b>	...	...	...	...	<b>\$94 32</b>

In addition, there is the discord-breeding element of labour—costing as follows—as nearly as can be estimated without an actual reference to the pay roll.

## COST OF LABOUR.

1 chief engineer	...	...	...	\$4 00 per day.
1 first assistant	...	...	...	3 50
2 oilers at \$2.25	...	...	...	4 50
2 boiler men at \$2 25	...	...	...	4 50
4 firemen at \$2	...	...	...	8 00
2 wheelers or passers at \$1.75	...	...	...	3 50
1 watchman	...	...	...	2 00
1 line man	...	...	...	2 50
1 dynamo man	...	...	...	3 00
1 dynamo man	...	...	...	2 50
9 wiremen at \$2	...	...	...	18 00
<b>Total</b>	...	...	...	<b>\$56 00</b>

In the general official headquarters are employed, a manager, a chief electrician, a superintendent, and a clerk, at an outlay of \$30 per day for salaries. There is an additional item of \$5 per day for office expenses, stationery, incidentals, &c., a total of \$35 per day.

This, divided up among five stations, assuming that the city can operate that many plants with such an office force, gives \$7 per day as the amount to be added to the foregoing \$56 for wages daily, and the \$94.32 daily expense previously estimated, making a grand total of \$157.32 cost for each and every day, Sunday included, for the maintenance of nominally 450 lights. By simple division we find the cost to be 34½ cents daily for one light.

This is a decided difference from the claim of 19 cents made by the authorities, and spread broadcast through the country. It may be thought by some the estimate is too high. It could not be shaved more than 10 per cent., even if it were high and the cost brought down to 31 cents. The difference, on a basis of 2,000 lights, between 19 cents and 31 cents, would amount annually to \$87,600, quite a tidy little sum.

But that is immaterial, as we are not picking a quarrel with the city people, but rather making use of their experience as a guide to us in our effort to ascertain the cost of running electric lights. We do not feel inclined to allow the reduction of 10 per cent., as figured above, but hold to the opinion that the figure should rather be increased 10 per cent., that is to 38 cents or 39 cents daily per lamp, for perfect economy does not obtain in affairs political. What with incompetent and overpaid help, and there is always some of this—what with vacations, sickness, loss of time, inferior contract coal, and unexpected breakdowns—the total will invariably be considerably above our figures. Of the 34 cents, perhaps 25 per cent. is outside of what can be justly considered as operating expenses.

By operating expenses is meant everything except rent, depreciation on buildings, taxes, insurance, interest, and management.

Perhaps 26 cents or 27 cents will be a fair estimate of the actual daily running expense per lamp. This by careful business management can be somewhat reduced where the lights are used in any considerable number.

The question then arises, or may arise, how can the ordinary merchant with but a very few lights hope to produce them for less cost per lamp the city, when the latter has all the advantages inseparable from a large plant.

It must be borne in mind that there are several channels open for practicing economy, of which a public body or corporation cannot very well take advantage.

The city of Chicago follows a most liberal policy in the management of its institutions of every kind, including the electric light station. It is generous without being lavish or wasteful. It is further handicapped by long running hours, necessitating two separate shifts of men, with the accompanying heavy expense of labour. The many directions in which the private manufacturers of lights can cut down expenses have been partly brought forward in earlier portions of the paper, and partly suggest themselves. What has been done can be done again. We can repeat in our stores and shops that which we see is being done in our streets. The consumer can supply himself with arc lights for 25 cents or less, for even as little as 20 cents per day per lamp.

The lights in a large commercial house, not far distant from this location, cost approximately 21 cents per day, figuring 5 lbs. of coal per ton per horse-power with 1 horse-power, and 5 per cent. over charged to each light. The firm pays \$3.75 a ton for coal. Carbons cost \$10 per 1,000, considerably more than the price paid by the city, but the most rigid economy is practised in burning them. Not a scrap is wasted. Globes cost a little more than in the case of the city. Labour costs a little less per light. A summary of the items is about as follows:—

- Eight cents per light for fuel.
- Three cents per light for incidentals.
- Two cents per light for carbons.
- Eight cents per light for labour.

The total is 21 cents. An additional 5 cents per day per lamp will pay all the expenses, such as rent, interest, taxes, insurance, &c., and that can possibly be charged to the plant, will bring the total to 26 cents—a sum entirely within the means of the business man. The result obtained in the last case represents perhaps the utmost economy that can be attained where the lights are run as a dis-

inct department of an institution, and agrees substantially with figures taken from the books of an establishment owning and running 200 arc lights. Here is an expenditure of no less than \$52 daily. If gas was burned \$125 worth per day would not give even an approximate equivalent light.

If lights are run from a single dynamo, which is cared for by the regular engineer of the establishment, and which takes up but little or no room in his department, the expense is cut down to as low as 15 or 16 cents daily. At such figures the light is really a necessity to a shrewd live merchant. The longer such a man puts off the adoption of the light in his business, just that much longer will he be behind his electrically-lighted rivals in the race for dollars.

The light has come to stay, and has taken its place with elevators and lifts as a necessary part of the machinery of an establishment that is forced to carry on its business in tall, deep, dark buildings, hemmed in on both sides by other buildings fronting on narrow streets and shut off from the light of day. It then becomes our duty as intelligent, progressive engineers, to seek at once for a better acquaintance with this method of illumination.

It will be found a most simple mechanical problem, on a par with the other machinery intrusted to our care, and no more difficult to manage than the ordinary elevators and engines. It is not at all mysterious. The atmosphere in the immediate vicinity of dynamos, converters and electric circuits is commonly supposed to be full of flying and flurrying volts, watts, amperes and other hidden subtleties. This need, however, occasion no alarm. They keep themselves in the background, and are not nearly so troublesome as hot boxes. The thoughts of them need deter no one from undertaking a study of them.

We have no more to fear from a volt than we have from a latent heat unit. Who ever saw the engineer that was afraid of a latent unit of heat? Do not then fear the electric terms. They are but the hidden elements of the forces with which we will have to deal. Master them.

## LONDON COUNTY COUNCIL.

At the weekly meeting held on Tuesday, the following report of the Parliamentary Committee was presented:—

### *Overhead Wires Bill.*

On the 28th October last the council, on the recommendation of the Highways Committee, passed the following resolution:—"That the council's Bill relating to overhead wires, in the form in which it passed the Select Committee of the House of Commons, subject, however, to such modifications as the Parliamentary Committee may consider necessary, be again introduced into Parliament next session; and that it be referred to the Parliamentary Committee to give the requisite notices and to take the other measures necessary for the purpose." In compliance with the terms of the above instruction, we have carefully considered the Bill, and have thought it desirable to omit clause 11 of the Bill of last session, which proposed to empower the council to make orders for carrying wires over, or supporting them, or attaching them to, private property. It will be remembered that this was one of the clauses upon which the opposition in the debate, which resulted in the rejection of the Bill, was based. With this exception the Bill remains as it left the Select Committee of the House of Commons. We have directed a copy of the Bill to be sent to each member of the council, and we recommend—

That the seal of the council be affixed to the petition for leave to bring in the London Wires Bill, and that the Bill be deposited with the petition, pursuant to the Standing Orders of Parliament, with such verbal alterations (if any), as the Parliamentary Committee may consider desirable.

### *Electric Lighting.*

We have considered the following resolution passed by the council on the 18th November:—"That the Parliamentary Committee be instructed to insert in the Council's General Powers Bill of next session a clause giving the council power to require any electric lighting company to supply electrical energy to the council's electric testing stations, even if the station for which the supply is required be beyond the limits of the company's area of supply, and authorising such company, subject to the usual notices, to break up streets for the purpose of laying the mains necessary to afford such supply to the testing station." We have consulted the Parliamentary agent on the subject, and are advised by him that it is too late to insert such a clause in the General Powers Bill, the notices not having provided for it. We have accordingly referred the matter back to the Highways Committee for further consideration, and have directed the agent's report to be laid before them. We recommend—

That the reference to the Parliamentary Committee be discharged.

The Chairman of the Highways Committee presented the following report:—

The London Electric Supply Corporation has given notice (Registered No. 134) of its intention to lay a service line from the St. Martin's Vestry Hall in Charing Cross Road to the Electrical Standardising Institution in the same thoroughfare, and proposes to extend the line to the council's electric testing station in Cranbourne Street. We see no objection to the proposed works, and recommend—

(a) That the consent of the council be given to the laying by the London Electric Supply Corporation of a service line from the St. Martin's Vestry Hall, Charing Cross Road, to the Electrical Standardising Institution in the same road, and to the council's electric testing station in Cranbourne Street, upon the following conditions:—That the company do give two days' notice to the council's chief engineer before commencing the works; that the proposed line be laid in the subway; that the position to be occupied by the service line in the subway be subject to the approval of the chief engineer of the council; and that the work of placing it to be carried out to his satisfaction.

(b) That the clerk be instructed to forward to the company a notice requiring it to lay the service pipe, referred to in its notice (Registered No. 134), in the subway of the Charing Cross Road.

We have considered two notices from the Notting Hill Electric Lighting Company: one dated 14th November, 1890 (Registered No. 135), of intention to lay mains in Stanley Crescent and Gardens, and a part of Kensington Park Road (1 plan); and the other, dated 20th November, 1890 (Registered No. 136), of intention to lay mains in Pembroke Road from High Street, Notting Hill, to the corner of Ladbroke Road (1 plan). The works referred to in these notices are of the same description as those of this company previously sanctioned by the council; and we recommend—

That the sanction of the council be given to the works referred to in the notices (Registered Nos. 135 and 136), dated 14th and 20th November, 1890, respectively, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the cover stones of the culverts under 20 inches wide shall be not less than 2 inches thick, and of the wider culverts not less than 2½ inches; and that where the culverts cross the carriage-way, there shall be at least 9 inches thickness of Portland cement concrete above the cover stones of the culvert in addition to the road material.

The Kensington and Knightsbridge Electric Lighting Company has given two notices (registered Nos. 137 and 138), dated 21st and 26th November, 1890, the first being for extension of mains in Alfred Place West (1 plan), and the second for similar works in Church Street, Kensington (1 plan). There seems to us to be no objection to these works; and we recommend—

That the sanction of the council be given to the works referred to in the two notices (registered Nos. 137 and 138), of the Kensington and Knightsbridge Electric Lighting Company, dated 21st and 26th November, 1890, respectively.

The subject of the subway in its many phases has been agitating the minds of the council for some time. The Improvements Committee, in considering one section of the question, have arrived at the opinion that persons who use subways for lying pipes and wires should pay for the privilege, and at the meeting recommended an application to Parliament for powers to compel companies to use the subway, and to enable the council to charge a rent for such user.

## PRACTICAL PROBLEMS.

### *1. Provisional or Intermittent Employment of Accumulators in a Distribution of 110 Volts.*

THE first practical problem published in our paper on the 4th of October, has brought us a certain number of letters which have led us to explain more fully certain points which were, perhaps, touched upon too briefly.

The particular case which we considered, in the first place, concerned a reserve installation, in which the three or four lamps that were eventually to be fed by the accumulators would only work at long intervals—merely a few hours per week. Under these conditions, a current charging 3 to 4 ampères 3 or 4 hours a day, supplied every day to the battery from 10 to 15 ampère-hours, or from 60 to 90 ampère-hours per week, a quantity sufficient to feed the lamps kept in reserve for night service or any similar purpose.

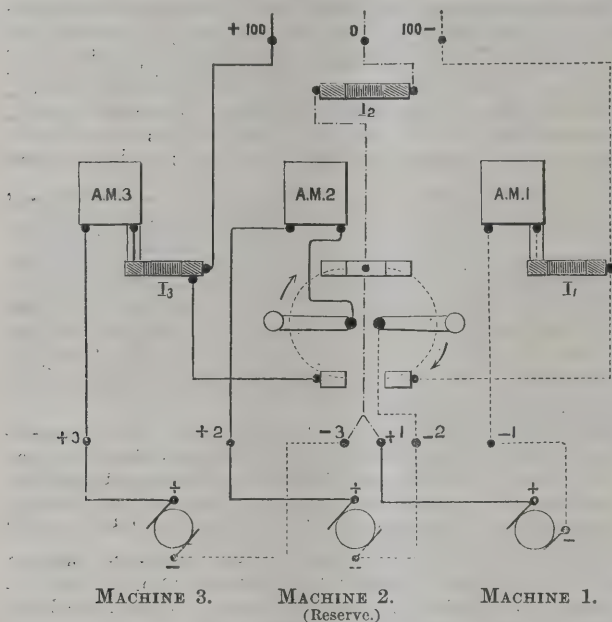
When the lamps are to work every day, it is evident that the number of 75-volt lamps placed in circuit with the battery of accumulators during the charge must be increased. The number of these lamps must be calculated in such a manner that the mean daily charge of the battery in ampère-hours exceeds by 10 to 15 per cent. the mean daily consumption in ampère-hours of the lamps supplied directly by the accumulators during the stoppage of the machine, this excess of 10 to 15 per cent. being calculated to take into account the rendering in quantity of the accumulators.

We do not think it necessary to give a diagram of

the mounting of the apparatus, it being very simple, and yet varying considerably according to the requirements of each case.

## 2. The Mounting of a System of Distribution with Three Wires.

The distributions with three wires, which are now pretty generally used, are particularly suited to the requirements of a small town, the population of which is not large enough for a service of distribution to be conveniently arranged with two wires, but yet too large for alternating currents and transformers to be employed.



The case of most frequent occurrence is that in which three shunt dynamos are used, two of which work at the same time, the third remaining in reserve, so as to be ready to be quickly substituted for one of the two others. Several methods have been adopted of connecting the system of canalisation with the machines and effecting readily the change of machines. One of the most simple is that adopted at the Cerlikon works, and which we have shown above. The six lower terminals of the system are connected respectively with the three shunt dynamos, 1, 2 and 3, machine 2 being the one in reserve, and the three upper terminals with the three distributing wires. Three ampèremeters are introduced respectively into the circuits of the three machines, in order to enable one machine to be substituted for another without any interruption of the service, by a simple manipulation of the exciting rheostats of the two machines between which the charge is to be effected. Three interrupters,  $I_1$ ,  $I_2$ ,  $I_3$ , enable the three lines of the system to be completely insulated, in order to facilitate the testing of the insulation of the circuit of distribution.

Without dwelling further on the many advantages of this method over the distribution by two wires in the case under consideration, we will merely mention one that has up to the present been almost overlooked, and which consists in carrying on the distribution after midnight by means of a single machine, whilst two working at 200 volts can be employed for the full service, from nightfall to midnight. The plan of distribution must, in this case, be modified, the connection of the two circuits with one machine entailing a special manipulation which, however, presents no difficulty.—*L'Electricien*, October 18th, 1890.

## LONDON GAZETTE NOTICES.

### Provisional Orders.

ACCORDING to the *London Gazette* for the 28th November, the following corporations and public companies will apply to the Board of Trade for provisional orders ;

Surbiton Improvement Commissioners ; Whitby Local Board ; Harrogate Corporation ; Tunbridge Wells Corporation ; Torquay Local Board ; South Shields Corporation ; Electric Installation and Maintenance Company (Maidstone and Leeds) ; Camberwell and Islington Electric Light and Power Supply ; Paddington and Bayswater Electric Light and Power Supply ; Yorkshire House-to-House Electricity Co. (Leeds) ; Stamford Hill, Tottenham and Edmonton Electric Light and Power Supply (Hampstead and Wandsworth) ; Laing, Wharton and Down Construction Syndicate (Whitechapel, Hackney and Shoreditch) ; Brush Electrical Engineering Company (City of London, Southwark, North of London, and Poole) ; Messrs. Latimer-Clark, Muirhead & Co. (St. Martin's-in-the-Fields) ; Provincial Electric Light and Power Supply (Aberystwyth) ; Ipswich Electricity Supply Company, Messrs. Laurence, Scott & Co. (Ipswich) ; Windsor and Eton Electric Light Company ; Manchester House-to-House Electricity Company (Withington District) ; Weymouth Electricity Supply Company.

### Tramways.

The Birmingham Corporation and the Bristol Tramways and Carriage Company, in seeking authority to construct new tramways, specify electricity among other methods of traction which they ask permission to use.

## PARLIAMENTARY NOTES.

### The Wreck of the *Serpent*.

IN the House of Commons on Wednesday last, Lord George Hamilton, in reply to a question as to ships' compasses said :—There were four compasses on board the *Serpent*, including two of Sir William Thomson's, and they were adjusted and inspected on July 6th and November 8th this year. The compasses were inspected after the manœuvres by the superintendent of compasses, and found in excellent order. On the occasion of a subsequent visit, the commander expressed his own and the navigating officer's great satisfaction with the behaviour of compasses during heavy weather in the manœuvres of 1890. Sir W. Thomson's compasses were introduced into the navy in 1884, and there are now very few of Her Majesty's sea-going ships that have not at least one.

### Telegrams.

Last Friday, Mr. Hobhouse asked the Postmaster-General if it was the rule of the telegraphic department of the General Post Office to refuse to compensate persons for loss or expense consequent on the loss, delay, or non-delivery of a telegram, and to refuse to communicate to the person injured the names of the defaulting office or officials. Mr. Raikes in reply said :—If the hon. member will be so good as to refer to clause 6 of the notice which is printed on the back of the forms on which the public write their telegrams, he will find an answer to the first part of his question. The clause reads as follows :—“The Postmaster General will not be liable for any loss or damage which may be incurred or sustained by reason or on account of any mistake or default in the transmission or delivery of a telegram.” As to the latter part of the hon. member's question, I may say that it is not the practice to give the names of the subordinate officials concerned in the transmission of a telegram or to name the office where a mistake may have occurred. Indeed, in a great many cases it would be impossible to do so, as it cannot always be ascertained with certainty where the fault has occurred or whether it is not due to some momentary disturbance of the wires or other apparatus. The conduct of any defaulting officials is always made the subject of strict inquiry by the department.

## PROFESSOR HERTZ.

A LUNCHEON was given on November 30th at the Langham Hotel by Prof. W. E. Ayrton. This gathering of a few celebrities, more especially of those belonging to the electrical branch of the scientific world, had been invited to meet Prof. Heinrich Hertz. It is well known that this gentleman has been just presented with the Rumford Medal by the Fellows of the Royal Society, as a recognition of his valuable work in carrying on Clerk-Maxwell's investigations, and showing the connection between light and electricity. The luncheon was followed by a crowded reception, at which Prof. and Mrs. Ayrton welcomed, among others, Sir Frederick and Lady Abel, Dr. Lodge, Prof. Poynting, Dr. and Mrs. Hopkinson, Mr. and Mrs. Crookes, Mr. Norman Lockyer, Mrs. Fawcett, Prof. and Mrs. Hughes, Prof. and Mrs. Perry, Prof. Foster, Prof. and Miss Thorpe.

We need hardly say that everyone was eager to see the lion of the day. Heinrich Hertz is quite a young man, for he is only thirty-three; he is slightly built; of a pleasing, but by no means German, cast of countenance; he speaks English fluently, as was plainly shown at the dinner given by the Royal Society. He used to act as assistant to Prof. Helmholtz; but on his marriage he removed to Bonn, where he holds office as a Professor of Physics in the University. It was pleasant to hear how his attention had first been attracted by a simple laboratory observation, which led him ultimately to the successful termination of his labours. He may have contributed only one pillar towards the support of that arch upon which science has to build a superstructure, but, we take leave to say, that the pillar is a very substantial pillar. It is no slight work to have shown how electricity can, like light, be reflected and refracted; like light also it goes in straight lines, and its flash can be stopped by the interposition of a suitable apparatus; that its waves are transversal and not longitudinal. By his experiments and his conclusions Prof. Hertz has much simplified all work on radiation.

## THE DINNER OF THE ROYAL SOCIETY.

(By A FESTIVE FELLOW.)

"WERE you at the dinner of the Royal Society?"

"No, sir, I was not. But as, I suppose, it was a grand day for electricians, I should much like to hear all about it from one who is acknowledged to be a light, indeed, in the electrical world."

"You are very kind. I must confess I felt very proud when I saw Sir William Thomson in the chair at our annual dinner in the Hôtel Métropole. It seemed too, that a Scotchman should occupy the chief place in a Society whose anniversary day is that dedicated to St. Andrew."

"Excuse me, but St. Andrew's Day is on November 30th, and you dined on—"

"The 1st of December. Quite so; but, you see, the 30th was on a Sunday; remember the weaker brethren. It would have been shocking to have a Presidential address and a dinner on the Sunday. Science, like other business, stands still on that day."

"Dear me, and does electricity cease to give light on that day, and sewers to give forth noxious gases, and fogs—"

"Pardon the interruption, but let me tell you about the dinner; that's a much pleasanter subject. I need not tell you that Stokes and Lubbock were there; the Lord Chancellor and a Marquis, the Italian Ambassador and Sir Philip Magnus. Professors abounded; Huxley and Hughes, Adams and Seeley, Hertz and Ayrton, Darwin and Lodge; sirs not a few—Sir D. Galton, Sir F. Abel, Sir B. Samuelson, Sir John—I mean—Sir Risdon Bennett, Sir A. This and Sir B. That; Doctors

of medicine and of science; and the power of the purse was finely represented by the Masters of the Drapers' and Clothworkers' Companies. There were the heroes of the evening, the medallists, Prof. Simon Newcomb—no, he was absent—Prof. Hertz, Prof. Ferrier, Dr. J. Hopkinson, Mr. Lockyer and Mr. Crookes."

"Very interesting, no doubt; but after all, you know, a list of names, even of scientifically intellectual giants, is rather—"

"What a Philistine you are. Would you like me to give you the *menu*?"

"No, I wouldn't—certainly not; it's quite enough for me to know that you had your dinner at the Hôtel Métropole, and as you had invited the Masters of two great City Companies, I expect you put your best feet foremost and had a sumptuous 'bankwet,' as Robert would say. Tell me some of the coruscations of wit and fancy, which must have flashed electrically through the dining room."

"Well, sir, I don't know what you mean to insinuate, but when I am asked by a gentleman to give an account of a dinner, I expect to be allowed to tell it my own way."

"Of course; quite right; so you shall. You were saying, I think, sir, that the new President—"

"Yes, sir. I was going to say (only you interrupted me) that the new President proposed, on the removal of the cloth, the health of 'The Queen and Royal Family,' and rightly dwelt upon the loyalty of the Royal Society, for we are loyal and royal. Then came 'Her Majesty's Ministers and the Members of the Legislature.' This gave Sir William an opening to compare the Constitution to an engine, which had the imperfection of not working backwards, and not being free from friction. If a perfect engine was nearly realised in a steam engine, some slight approach to perfection might reasonably be looked for in the political machine. Anyhow, H.M. Ministers showed great devotion to the public service."

"How did Lord Halsbury take the suggestion?"

"Very good humouredly. He explained that the political engine was put together with very animated bolts and screws, so that much friction was unavoidable. He went on to propose the toast of 'The Royal Society,' introducing it with an anecdote about an orator, who asked a friend what he should say on a particular occasion. 'To whom are you going to talk?' 'Oh, I'm going to talk to the Athenians.' 'Well, if you say something pleasant about the Athenians, they are sure to cheer you.' Acting upon this thought, the Lord Chancellor reminded his fellow-guests, how the light which enabled them to see each other was due to the researches of Sir William and men like him, who had made the great physical energies of the universe subservient to the use of mankind. He modestly drew in his horns after that; he felt nervous—"

"That's good! Lord Halsbury nervous! Beg pardon; you were saying—"

"He felt nervous lest some F.R.S. should tell him electricity was not physical, and was not an energy. Then he made the somewhat trite remark that electricity enabled us to receive news almost simultaneously from all parts of the world. To the legal mind, accustomed to the slow rate at which justice travels, I have no doubt this is an impressive fact about electricity."

"Did the president make a good speech in reply?"

"He very courteously, as the Italian ambassador was present, mentioned that the Academia in Florence and other societies were older than the Royal Society. But still two centuries and a half was a good age humanly, though not geologically speaking, and the Royal Society has been the fruitful parent of philosophical societies everywhere. By way of novelty, Sir William carried us back to what the Society did in the first 20 years of its existence. It took Newton—Sir Isaac Newton, you know—by the hand, and made known to the world outside Cambridge all his labours in optical research. Newton might be almost called the spoilt darling of the Society, for it was due to the indefatigable labours of

the Society's secretaries that Newton's work between 1665 and 1682 were published to the world. To Hook and Halley were chiefly due the publication of the 'Principia Mathematica de Motu Corporum.' Sir William ended modestly enough; for while he felt the high honour conferred upon him, he could not but think that all credit for the Society's good work must be given to the Society's permanent officers. But the President's work was not over. He was up again, without even the interval of a song, to propose the medallists. Here again he enlarged rather more than was agreeable to most of his audience, upon the special work of some of the medallists; as he had given us a most detailed account of Newton, so he elaborated upon Newcomb and the rest. However, all things come to an end. It was time for Dr. Hopkinson to reply to the toast. With an occasional reference to notes, he told us how Newcomb had advanced Newton's theory of gravitation by applying it to the details of the motion of the moon and other planetary bodies; how Prof. Emil Fischer had furthered chemistry by synthetically producing from inorganic sources many definite sugars; how Wallace had chivalrously given way to Darwin; how Dr. Ferrier worked on the surgical treatment of the brain. When he reached that point, he bitterly denounced the restrictions on experimental work. I have no doubt he will hear further about that part of his speech from Miss Cobbe and the *Spectator*. With a pretty compliment to his foster-father in electrical and magnetic science, Sir William Thomson, that speech was ended. Our Bonn Professor, Hertz, next claimed our attention with a capitally-delivered speech, entirely in English, and spoken without any notes. He was fully aware of the high honour which had been done him. His only ground of apprehension when treading on English soil was that he would have to encounter a certain feeling of national jealousy; but, on the contrary, his first and most friendly communication was with those who might in ignorance be called his rivals, Dr. Lodge and Prof. FitzGerald. He was glad he had come to England to receive this medal, which was an earnest indeed of future work; for so had he seen, face to face, men whom hitherto he had worshipped only at a distance. Of this he was sure, that his work, so kindly praised, would sooner or later have been done by the men who so heartily welcomed him."

"Was there much more speech-making?"

"Sir John Lubbock proposed 'The Retiring President.' Perhaps, as you hail from Cambridge, you know the work he has done on the steady motion of incompressible fluids, on crystals and spectrum analysis. In reply, Sir Gabriel stated that he owed much to the Cambridge Philosophical Society, and, though he was retiring from the presidentship, he had no intention of resting from his labours as a member of the Council of the Royal Society. After 'Our Guests' had been proposed, and the Italian Ambassador and Sir Edward Hamley had replied to the same, we all said 'Good night,' and went our several ways."

## REVIEWS.

*Electric Bell Construction.* By F. C. ALLSOP. E. and F. N. Spon, 125, Strand, London.

The substance of this book appeared as a series of articles in the *English Mechanic*. The work is thoroughly practical in its character, and is also very complete, almost every variety of bells and their allied mechanism being fully and carefully described. We are somewhat surprised, however, to find not a word said upon the construction of the Leclanché battery, indeed, the opening chapter, in which the general principle of a battery is described, might almost lead anyone to imagine that the Leclanché battery consists of a plate of copper and one of zinc in dilute sulphuric acid. Again, the description of the joining up of several cells

in series would certainly lead one to suppose that Leclanché cells had no resistance, which is very far from being the case. A feature in the book is the fact that all the illustrations are drawn to scale, so that the dimensions of any of the apparatus can at once be obtained. Magneto as well as battery bells are described, and all details of their construction very fully explained. Altogether the book is a decidedly useful one.

*Practical Electrical Notes and Definitions.* By W. Perren Maycock. Second Edition. E. and F. N. Spon, 125, Strand, London.

The second edition of this book is a decided advance on the first, though we observe that the rhapsodical rubbish, to which we drew attention in our notice of the first edition, still remains. The book, in its present form, hardly accords with its shape, which is of the pocket-book pattern, and we do not expect in such books to find illustrations of machines which are left undescribed, though, possibly, these illustrations may be useful to amateurs as a means of identifying any particular machine they may come across. On page 203, it is stated that a microphonic relay receives a message and transmits it afresh over another section of line; we are quite certain Mr. Maycock has never seen such a relay at work, for no one has yet succeeded in making one. Although the whole work contains much useful matter in the shape of notes, tables, diagrams, rules, &c., there is, we think, a good deal too much space devoted to "definitions," which are unsatisfying in their character, and might be more profitably replaced by something more practical. We notice that the use of the modern terms "conductance," "resistivity," &c., has been introduced. The whole work has had the advantage of having been "overlooked" by Professor Silvanus Thompson and Mr. J. Swinburne; quite so!

*The Electric Light Popularly Explained.* By A. BROMLEY HOLMES. 5th edition. London: Bemrose and Sons, 23, Old Bailey.

The first edition of this book was published in 1882, and the fact that a fifth edition has been called for speaks well for the production. A good deal of additional matter has been worked in and revision carried out. The last chapter, which deals with the "Cost of the Light," is, perhaps, hardly entirely satisfactory; but, then, the subject is one which it seems almost impossible to fairly get at.

*Physical Memoirs: selected and translated from foreign sources, under the direction of the Physical Society of London.* Vol. I., part 3. London: Taylor and Francis, Red Lion Court, Fleet Street.

This issue consists of a paper by Prof. J. D. Van der Waals, on "The Continuity of the Liquid and Gaseous States of Matter."

## THE QUESTION OF PUBLIC LIGHTING IN BUDAPEST.

[FROM A CORRESPONDENT.]

BY the occasional insertion of moderately circumstantial communications, you have kept your readers acquainted with the different phases of this question in Budapest. They will probably read with interest the following extract from the recent report of the Commission on Public Lighting, especially as it furnishes a clear view of the genetic development of this affair, which is calculated to prove instructive to other municipal bodies.

The sub-committee appointed for the especial conduct of the negotiations obtained in the first place an opinion from the Director of Buildings (an official somewhat like the "Dean of Guild" in a Scottish

city), the head accountant, and the chief fiscal. The prevalent opinion, in accordance with the explanations received, was to the effect that "in view of the revolution now taking place in the sphere of public lighting, it did not appear suitable to take the use of any other new means of lighting into serious consideration, and that "the question of the redemption of the gas-works could be advantageously considered only if the valuation provided for in the agreement had been carried out, and the capital required for the redemption had been approximately estimated. All this, however, was no reason why the metropolis should not make use of the right secured to it under section 4 of the gas agreement, concerning the (partial) adoption of a new system of lighting.

Proceeding from the point of view just indicated, the sub-committee invited the gas company to declare whether, and under what conditions, it was prepared to supply electric lights, on the one hand, for public purposes, and, on the other, for private consumers. Further negotiations were to be opened with the gas company to ascertain whether, and under what conditions, it was prepared to concede a reduction of price for the private consumption of gas before the expiry of the agreement, and undertake the private lighting gratuitously?

The gas company replied, in the communication of September 5th, 1889, that, in accordance with the wish of the city, it was prepared to undertake the introduction of the electric light on certain conditions (enumerated in detail), and in return for a prolongation of the gas agreement for 10 years, gradually to reduce the price of gas to private consumers to 11 kreutzers, and to supply the street lighting gratuitously on the basis of the quantity consumed in 1888, so that the city would only have to keep the street lamps in order.

After ripe deliberations, the sub-committee resolved that the conditions for the introduction of the electric light were too onerous, and that the gas company would thus obtain a monopoly of the electric light. Hence the offer, as it stood, could not be accepted, but, with considerable modifications, it might be taken as the basis of further negotiations. "Hence the sub-committee—considering that the redemption of the gas-works would be unreasonable, since there is a general movement in the matter of public lighting, and new technical advances and inventions are daily coming forward—did not object to a prolongation of the agreement, but urge that it must be made a fundamental principle that with such prolongation the monopoly of the gas company for the introduction of any illuminating agent must expire, and the capital must have its hands in this respect unfettered. The conditions of the committee were in fine the following: A ten years' prolongation of the gas agreement, reduction of the price of gas to private consumers to 10 kreutzers per cubic meter; free supply of the street lamps without reimbursement for the expense of their erection; no exclusive right or privilege for the electric or any other new light; finally, the stipulation that the price of the electric light for the street lamps must not be higher than that of the gas lamps at present.

On March 31st, 1890, the desired explanation of the gas company was handed in. It was willing to forego the exclusive right of introducing any new means of illumination which had been secured to it by contract. If the gas agreement were prolonged for 15 years the company was willing to concede to the municipality the unlimited right of disposal; the price of the gas supplied to the private consumers should be reduced to 10½ kreutzers; the gas required for street lighting should be furnished gratuitously after the expiry of the present agreement, and after the cost incurred for maintaining the lamps according to the proportion of 1888 had been refunded.

The municipal accountant calculated that these conditions—disregarding the great value which the surrender of the exclusive privilege possesses—would involve yearly a saving to private companies of 1,250,000 florins during the time of the present agreement, and that it would imply for the community a yearly

economy of 240,000 florins, dating from December 16th, 1895, and it would consequently be acceptable with the following modifications and additions. 1, The city is to be free after 10 years to redeem the gasworks; 2, the private gas price to be reduced to 10 kreutzers; 3, half the cost of the street lighting is to be at once given up, and the rest after the expiry of the present agreement; 4, the city to refund only half the cost of maintenance of the gas-lamps; 5, the gas to be supplied gratis for the streets is to be calculated according to the consumption of 1889, taken as a minimum; 6, the gas company to establish an independent management in Budapest.

To these more recent proposals the gas company replied on June 12th, 1890. The redemption of the gasworks before the expiry of the 15 years cannot be accepted; the company accepts the reduction of the private gas price to 10 kreutzers, on condition that the production cost of gas does not rise, and that no further sacrifices are to be required for public purposes. The immediate surrender of half the cost of public lighting, and half the cost of maintaining the lamps cannot be conceded. The proportion of consumption for 1889 is accepted, but not as a minimum, but either as a fixed or a variable yield. The local direction of the gas company will be invested with powers to decide on the spot all affairs concerning the Budapest Gas Works.

Therewith the negotiations were completed, and the General Commission resolved to accept the offers of the gas company, with the following supplements:—The ultimate redemption of the gas works will not take place before the lapse of 15 years' agreement; the price for private gas, not to be used for lighting, to be reduced to 8 kreutzers per cubic metre; the proportion of consumption of the gas to be supplied gratis for street lighting is to be assumed as variable, adhering to the proportions of 1889. Several gas testing stations are to be erected in the city, and the price of the gas consumed in municipal buildings is to remain in future 7.42 kreutzers for cubic metre.

## NOTES.

**Removal.**—Messrs. Nalder Bros. have now removed their offices and works to their new premises at 16, Red Lion Street, Clerkenwell.

**Fire at an Electrical Engineers.**—Last Saturday afternoon a fire broke out on the premises of Messrs. Gent and Co., electricians, Leicester. It was, however, extinguished before much damage was done.

**The Delany Battery Strip.**—This is a simple contrivance, invented by P. B. Delany, of South Orange, N.J., to prevent the creeping of salts in the gravity, Leclanché, and other primary batteries. The device is simply a strip made of rubber cloth and applied to the inside of the rim of the battery jar. One side of the strip is covered with a sticky compound, and when the strip is properly applied it will never come off the jar. The strip offers a mechanical obstruction to the creeping salt which masses underneath it, and is re-dissolved in the battery fluid each time that water is added to the solution to make up for evaporation. All waste and exhaustion of batteries by local action by this means, it is claimed, is prevented, and shelves are kept perfectly clean and dry. When the strip is properly applied no amount of washing or wetting will affect it.

**Telephonic Communication with Lighthouses.**—Henley's Telegraph Works have recently manufactured a submarine telephone cable which has been laid by the Pilot authorities in Finland between Hanzo, the most southern point of Finland, to a lighthouse 2½ miles from the coast. We hear that the cable has been found to work well.

**Royal Society's Medal.**—Dr. Hopkinson will receive the Royal Society's medal for his researches in magnetism and electricity.

**Proposed Electric Railway in Vienna.**—In connection with the underground railway projected for Vienna, the Austrian Minister of Commerce has resolved to send two engineers to London to study the underground electric railway recently established between the City and South London.

**The Old Students' Association.**—The first smoking concert of the season, in connection with this association, was held at Mason's Hall Tavern on the 28th ult., Mr. W. B. Esson, the president, occupying the chair. The musical programme was of a first-class character, and in point of numbers the concert was a great success, there being not an empty seat in the room. Amongst those present were:—Vice-Presidents A. Reckenzaun and A. T. Snell, Past-Presidents Dr. W. E. Sumpner and Mr. Adams, Profs. Ayrton and Perry, Mr. L. B. Atkinson, Mr. John Gray, B.Sc.; and Mr. Holland, B.A. A cordial vote of thanks was given to the performers and to the musical committee. There is but little doubt that the O.S.A. has reached a new era in its existence, and with such energetic directors there is now nothing to prevent its growth into a body which will eventually fill an important position in the scientific world, and at the same time possess social qualifications which will keep its members continually in touch with one another.

An ordinary general meeting was held at Finsbury Technical College last night, when a paper was read by Hamilton Kilgour, member, on "Notes on Economy of Conductors in Systems of Distribution in Electrical Energy."

**S.S. Silvertown.**—This telegraph steamer, owned by the India-Rubber, Gutta-Percha, and Telegraph Works Company, is reported to have arrived at Coronel (Chile) on November 25. It will be remembered that she carries the submarine cable for extending the Central and South American Telegraph Company's lines from Lima, where they at present terminate, to Yquique and Valparaiso.

**A French Manufactory of Submarine Cables.**—A Calais telegram to the *Temps* says:—The factory for the manufacture of submarine cables, which the General Telephone Company is constructing at Calais, to the east of the Carnot basin, is finished. The opening will take place, we are told, in the early part of December. The building of this factory is, from a national point of view, of real importance, since, up till now, England alone possessed a monopoly of submarine cable-making.

**The Aron Meter.**—Dr. Aron's electricity meter received a gold medal at this year's exhibition at Palais de la Industries at Paris.

**Provisional Orders.**—The time limited by the Electric Lighting Act within which official notice must be given of all provisional orders, expired on the 28th ult. From the notices given it appears that 76 separate orders will be applied for, 17 of them relating to various portions of London and suburbs.

**Electric Light in Hampstead.**—The Hampstead Vestry will oppose all applications made by companies or others to the Board of Trade for powers to light the borough by electricity. It has empowered its Electric Lighting Committee to obtain a plan and estimate from a specialist so that it may consider the advisability of undertaking the work itself.

**Theatre Lighting.**—Messrs. Dickinson & Co. have secured from Mr. Norman Forbes a contract to install the electric light throughout the Globe Theatre.

**Mr. Muirhead and the National Telephone Company.**—We have received another and rather lengthy letter from Mr. Muirhead, which, however, shows no improvement in the relations with the telephone company. We do not see that anything is to be gained on either side by allowing further correspondence on this subject.

**Gas and Electricity in Bordeaux.**—The Bordeaux Gas Company is now lighting the stage of the Grand Theatre by electricity. The offices of the company are also lighted electrically, and the plant is installed on the latter's premises.

**New Telegraph Cable.**—A Bill approving of the agreement made on October 12th last with the Grande Compagnie des Telegraphes du Nord for the laying and working of a second cable between Calais and Fanoë in Denmark has been presented to the French Chamber of Deputies. The new convention reserves to the State certain advantages, in exchange for which it gives to the company financial assistance, which, for the two cables, will not exceed £6,800.

**New Central Station in Vienna.**—The central station of the International Electricity Company was put in operation on the 14th ult. About 21 miles of cable have been laid throughout the town and suburbs.

**Lighting of Karáusebes.**—This small town in the south of Hungary is now lighted electrically, the plant being installed in a saw mill. In addition to the public illumination, 500 lamps for private consumers are in use.

**New Battery Company.**—The Compagnie Francaise des Piles Universelles has been formed in Paris with a capital of £8,000 divided into 200 shares of £40 each.

**Edinburgh Exhibition.**—In our notice of the exhibits at the Edinburgh Electrical Exhibition, we called attention to the very fine display made by Messrs. Buller, Jobson & Co., Limited, now Bullers, Limited, of Birmingham, Hanley, Dudley, Glasgow and London, of telegraph insulators, brackets, clips, poles, stay rods, channel arms, and all the various articles made by them for telegraphic, telephonic and electric lighting purposes. Facing the index to advertisements will be found an illustration of this unique exhibit, which arrested the attention of every visitor to the machinery hall. This old-established firm, as our readers are aware, has lately purchased an extensive site at Cheston Road, Birmingham, for the erection of a new works with modern plant, suitable for the production of its manufactures. Those engaged in telephage will be interested to know that Messrs. Bullers, Limited, are supplying an insulator patented by Mr. E. J. Chambers (a director of the company), which is arranged to grip and insulate the cable at the same time, and to allow the grooved wheels of the travelling carriage to pass easily over the tops. These insulators are shown at the left hand corner of the illustration. We understand that Messrs. Bullers, Limited, will exhibit at the Glasgow Industrial Exhibition.

**Electric Welding.**—Sir Douglas Galton, K.C.B., Mr. W. H. Preece, F.R.S., Mr. Ashton (of the Royal Laboratory, Woolwich), and other gentlemen, visited Messrs. Lloyd and Lloyd's Coombes Wood Tube Works on Friday last, for the purpose of inspecting their installation of electric welding. The process used is that known as the Bernardos process, the sole right to the use of which has been acquired by Messrs. Lloyd and Lloyd, and the welding is, as our readers are already aware, effected by means of the arc. The distinguished visitors were much delighted with all they saw, and expressed themselves most favourably as to the achievements and possibilities of arc welding.

**Telephony on the Congo.**—The *Ville de Ramanah*, which recently left Antwerp for the Congo, had on board the wires, &c., necessary for the installation of the first telephone line to be erected along the Congo railway. The wire is of phosphor bronze, and the apparatus is of the type adopted by the administration of the Belgian Telegraphs for their private and service lines.

**The Institution of Electrical Engineers.**—The annual general meeting of the Institution will be held on Thursday, December 11th, at 8 o'clock in the evening, for the reception of the annual report of the Council, and for the election of Council and officers for the year 1891. The following papers will be further discussed:—"The Efficiency of Secondary Cells." "On the Chemistry of Secondary Cells." By Prof. W. E. Ayrton, F.R.S., Vice-President, C. G. Lamb, B.Sc., and E. W. Smith, Associates.

**Telephone Switchboards.**—We have received a long communication from Mr. Hubert F. Jackson on "Improvements in Telephone Exchange Switchboards." Unfortunately it came to hand after the bulk of our pages had gone to press, so we must perforce hold it over till next week.

**Death from Electricity.**—Reuter telegraphs from St. Louis, United States:—An electric light company's employé came into contact with an electric light wire here on Saturday and was immediately killed.

## NEW COMPANIES REGISTERED.

**Holmes and Sons, Limited.**—Capital £14,000, in £5 shares. Objects: To take over the business of Holmes and Sons, engineers, of Norwich, and to trade as mechanical engineers, machinists, metallurgists, and electricians. Signatories (with 1 share each): \*Garrett Taylor, \*James Holmes, \*G. T. Holmes, F. R. Holmes, all of Norwich; \*Clare Sewell Read, Thorpe, Norfolk; \*C. Waters, Postwick, Norfolk; \*J. W. Reynolds, Keswick, Norfolk. The signatories denoted by an asterisk are the first directors. Qualification, 50 shares. Remuneration, £150 per annum, divisible. Registered 24th inst. Solicitor, Mr. S. Cozens Hardy, Norwich.

**Weymersch Electric Battery Company, Limited.**—Capital, £20,000 in £5 shares. Objects:—To carry on the business of an electric light company in all branches, and to enter into an agreement with Hy. Weymersch, Leoné Sara McKenzie and Arthur McKenzie Cardwell. Signatories (with 1 share each): \*A. M. Cardwell, 29, St. James' Street; \*H. Weymersch, 17, Glengarry Road, E. Dulwich; W. S. T. Martin, 17, Melbourne Grove, E. Dulwich; E. C. de Segundo, 7, Victoria Street, Westminster; F. Fanta, 10, Moorgate Street; C. F. Jones, Fox Hill, Upper Norwood; Mrs. L. S. McKenzie, 21, Talbot Road, Bayswater. The first directors are the first two signatories and T. H. Cardwell and W. A. Cardwell. Qualification, 100 ordinary shares, and the company in general meeting will determine the remuneration. Registered, 28th ult., by Harwood and Stephenson, 31, Lombard Street. Registered office, 2, Victoria Mansions.

**J. & S. Roberts, Limited.**—Capital, £120,000 in £10 shares. Objects:—To take over the business of ironfounders carried on by Messrs. John and Samuel Roberts at the Swan and Small Heath Foundries, West Bromwich, and to carry on business as ironmasters, mechanical and electrical engineers and manufacturers of electric plant and appliances. Signatories (with 1 share each): \*John Roberts, \*S. Roberts, \*J. Hampton; James Roberts, \*Hy. Roberts, Thos. Roberts and W. A. Roberts, all of West Bromwich. The signatories denoted by an asterisk and H. J. Roberts, Isaac Jenks and Walter Jenks are the first directors. Qualification, 50 fully paid ordinary shares. Registered, 20th ult., by Sharpe, Parker & Co., 12, New Court, Carey Street.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Elmore's French Patent Copper-Depositing Company, Limited.**—An agreement of 10th September between Elmore's Foreign and Colonial Copper-Depositing Company, Limited (the vendors), of the first part, Woodhouse and Rawson United, Limited, of the second part, and this company of the third part, provides for the sale to this company of the French patents of the vendor company, the consideration being as follows: £8,350 within seven days of going to allotment, £75,150 in cash, and £66,500 in fully paid shares, and a premium of 10s. each on any of the 66,750 shares issued to the public which may be allotted to any person or persons other than the vendors. Provided always that should the Woodhouse Company consider that applications for shares in this company, over and above those to be allotted to the vendors are insufficient, then the company shall be at liberty to pay any part of the said cash in fully paid shares at par. Under this agreement Francis Edward Elmore and Alexr. Stanley Elmore are appointed standing consulting metallurgical chemists of the company for three years at a remuneration of £100 per annum each. Registered office, 64, Cannon Street.

**Elmore's Austro-Hungarian Patent Copper Depositing Company, Limited.**—An agreement of 26th September, filed 20th October, provides for the purchase by this company of the patents for Austria-Hungary belonging to Elmore's Foreign and Colonial Patent Copper-Depositing Company, Limited. The purchase consideration is £10,000 in cash within seven days of going to allotment; secondly, £40,000 in cash and £50,000 in fully paid shares, and a premium of 10s. each on any of the 75,000 shares issued to the public which may be allotted to any person or persons other than the vendors, with the same discretionary power to the Woodhouse Company as in the French Company, for the payment of any part of the said cash in fully paid shares at par. Messrs. Francis Edward Elmore and Alexr. Stanley Elmore are appointed standing consulting metallurgical chemists of the company, at a remuneration of £100 per annum each.

**Metropolitan Electric Supply Company, Limited.**—The annual return of this company, made up to the 21st ult., was filed 27th ult. The nominal capital is £500,000, divided into 49,900 ordinary, and 100 founders' shares of £10 each. The shares taken up are 45,932 ordinary, and 100 founders', and of these 2,132 are considered as fully paid. Upon 43,900 shares £8 per share has been called, the calls paid amounting to £342,598 9s., and unpaid to £8,601 11s.

**Brazilian Submarine Telegraph Company, Limited.**—The directors of this company have to-day declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum.

## TRAFFIC RECEIPTS

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of November were £3,100 as compared with £3,112 in the corresponding month of last year. The receipts for the month of August estimated at £2,900, realised £2,913.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of November show £2,732 against £2,497 in the corresponding period of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of November, 1890, amounted to £44,742, as against £44,147 in the corresponding period, an increase of £595.

The Eastern Telegraph Company, Limited. The receipts for the month of November were £58,975, as against £60,578 for the same period of 1889, or a decrease of £1,603.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 28th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £5,116.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month of November, 1890, were £4,850.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (November 27.)	Closing Quotation. (December 4.)	Business done during week ending December 4, 1890.	
					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	98 — 101	100 <sup>3</sup> / <sub>4</sub>	...
1,381,380	Anglo-American Telegraph, Limited ... ..	Stock	48 <sup>1</sup> / <sub>2</sub> — 49 <sup>1</sup> / <sub>2</sub>	48 <sup>1</sup> / <sub>2</sub> — 49 <sup>1</sup> / <sub>2</sub>	49 <sup>3</sup> / <sub>4</sub>	48 <sup>3</sup> / <sub>4</sub>
2,809,310	Do. do. 6 p. c. Preferred ... ..	Stock	85 — 86 <sup>1</sup> / <sub>2</sub>	85 — 86	86 <sup>3</sup> / <sub>4</sub>	85 <sup>3</sup> / <sub>4</sub>
2,809,310	Do. do. Deferred ... ..	Stock	13 <sup>1</sup> / <sub>2</sub> — 13 <sup>3</sup> / <sub>4</sub>	13 <sup>1</sup> / <sub>2</sub> — 14	14 <sup>1</sup> / <sub>2</sub>	13 <sup>3</sup> / <sub>4</sub>
180,000	Brazilian Submarine Telegraph, Limited ... ..	10	11 <sup>1</sup> / <sub>2</sub> — 11 <sup>3</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>2</sub> — 11 <sup>3</sup> / <sub>4</sub>	11 <sup>3</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>2</sub>
84,500	Do. do. 5 p. c. Bonds ... ..	100	101 — 103	101 — 103	...	...
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 — 108	104 — 108	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416 ...	3	1 — 1 <sup>1</sup> / <sub>2</sub>	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	1 <sup>9</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>2</sub>
63,416	Do. do. Preference, Nos. 1 to 63,416 ...	2	1 <sup>1</sup> / <sub>2</sub> — 1 <sup>3</sup> / <sub>4</sub>	1 <sup>3</sup> / <sub>4</sub> — 2	1 <sup>3</sup> / <sub>4</sub>	1 <sup>3</sup> / <sub>4</sub>
\$7,216,000	Commercial Cable, Capital Stock ... ..	\$100	102 — 104	102 — 104	...	...
224,850	Consolidated Telephone Construction and Maintenance, Ltd. ...	14/-	7 <sup>1</sup> / <sub>2</sub> — 7 <sup>9</sup> / <sub>16</sub>	7 <sup>1</sup> / <sub>2</sub> — 7 <sup>9</sup> / <sub>16</sub>	...	...
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	5 <sup>1</sup> / <sub>2</sub> — 5 <sup>3</sup> / <sub>4</sub>	...	...
16,000	Cuba Telegraph, Limited ... ..	10	11 <sup>1</sup> / <sub>2</sub> — 12	11 <sup>1</sup> / <sub>2</sub> — 12	11 <sup>3</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>2</sub>
6,000	Do. do. 10 p. c. Preference ... ..	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited ... .. (£4 only paid)	5	3 <sup>3</sup> / <sub>4</sub> — 4 <sup>1</sup> / <sub>2</sub>	3 <sup>3</sup> / <sub>4</sub> — 4 <sup>1</sup> / <sub>2</sub>	...	...
6,000	Do. do. 10 p. c. Preference ... ..	5	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	9 — 10	9 <sup>1</sup> / <sub>2</sub>	...
60,710	Direct United States Cable, Limited, 1877 ... ..	20	10 — 10 <sup>1</sup> / <sub>2</sub>	10 <sup>1</sup> / <sub>2</sub> — 10 <sup>3</sup> / <sub>4</sub>	10 <sup>3</sup> / <sub>4</sub>	10 <sup>3</sup> / <sub>16</sub>
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000 ... ..	10	13 <sup>1</sup> / <sub>2</sub> — 14 <sup>1</sup> / <sub>2</sub>	13 <sup>1</sup> / <sub>2</sub> — 14	14	13 <sup>3</sup> / <sub>4</sub>
70,000	Do. do. 6 p. c. Preference ... ..	10	14 <sup>1</sup> / <sub>2</sub> — 15	14 <sup>1</sup> / <sub>2</sub> — 15	14 <sup>3</sup> / <sub>4</sub>	14 <sup>1</sup> / <sub>16</sub>
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	...	...
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock ... ..	Stock	103 — 106	103 — 106	105 <sup>1</sup> / <sub>2</sub>	104 <sup>1</sup> / <sub>2</sub>
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13 <sup>1</sup> / <sub>2</sub> — 14	13 <sup>1</sup> / <sub>2</sub> — 14	14	13 <sup>3</sup> / <sub>4</sub>
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891 ...	100	100 — 102	101 — 103	...	...
91,800	{ Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326 }	{ 100 }	{ 102 — 105 }	{ 102 — 105 }	{ ... }	{ ... }
325,200	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400 ...	100	102 — 105	102 — 105	...	...
145,300	{ Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	{ 100 }	{ 101 — 104 }	{ 101 — 104 }	{ 102 <sup>3</sup> / <sub>4</sub> }	{ ... }
198,200	Do. do. do. to bearer, Nos. 2,344 to 5,500 ...	100	101 — 104	101 — 104	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100 ...	10	7 <sup>1</sup> / <sub>2</sub> — 8 <sup>1</sup> / <sub>2</sub>	7 <sup>1</sup> / <sub>2</sub> — 8 <sup>1</sup> / <sub>2</sub>	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000 ...	5	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>2</sub>	4 <sup>1</sup> / <sub>2</sub> — 5 <sup>1</sup> / <sub>2</sub>	5 <sup>1</sup> / <sub>16</sub>	...
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 1 to 70,000 ...	2	3 <sup>1</sup> / <sub>2</sub> — 4	3 <sup>1</sup> / <sub>2</sub> — 4	3 <sup>1</sup> / <sub>16</sub>	3 <sup>1</sup> / <sub>2</sub>
67,385	{ Elmore's Wire Manufacturing, Limited, Nos. 1 to 67,385 issued at 1 pm. all paid ... }	{ 2 }	{ 1 <sup>1</sup> / <sub>2</sub> — 2 <sup>1</sup> / <sub>2</sub> }	{ 1 <sup>1</sup> / <sub>2</sub> — 2 <sup>1</sup> / <sub>2</sub> }	{ 2 <sup>1</sup> / <sub>16</sub> }	{ 1 <sup>1</sup> / <sub>2</sub> }
20,000	Fowler-Waring Cables, Nos. 301 to 20,000 ... (£4 only paid)	5	2 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>2</sub>	...	...
180,227	Globe Telegraph and Trust, Limited ... ..	10	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> — 9	9	8 <sup>1</sup> / <sub>16</sub>
180,042	Do. do. 6 p. c. Preference ... ..	10	14 <sup>1</sup> / <sub>2</sub> — 15	14 <sup>1</sup> / <sub>2</sub> — 14 <sup>3</sup> / <sub>4</sub>	14 <sup>3</sup> / <sub>4</sub>	14 <sup>1</sup> / <sub>2</sub>
150,000	Great Northern Tel. Company of Copenhagen ... ..	10	15 <sup>1</sup> / <sub>2</sub> — 16 <sup>1</sup> / <sub>2</sub>	15 <sup>1</sup> / <sub>2</sub> — 16 <sup>1</sup> / <sub>2</sub>	16 <sup>1</sup> / <sub>2</sub>	15 <sup>1</sup> / <sub>2</sub>
15,000	Do. do. 5 p. c. Debs. (issue of 1881) ... ..	100	101 — 104	101 — 104	...	...
230,000	Do. do. do. (issue of 1883) ... ..	100	104 — 107	104 — 107	106 <sup>1</sup> / <sub>2</sub>	...
9,384	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000 ...	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	...	...
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	11 <sup>1</sup> / <sub>2</sub> — 12 <sup>1</sup> / <sub>2</sub>	...	...
41,800	India-Rubber, Gutta-Percha and Telegraph Works, Limited ...	10	18 — 19	18 — 19	18 <sup>3</sup> / <sub>4</sub>	18 <sup>1</sup> / <sub>2</sub>
200,000	Do. do. 4 <sup>1</sup> / <sub>2</sub> p. c. Deb., 1896 ... ..	100	100 — 102	100 — 102	...	...
17,000	Indo-European Telegraph, Limited ... ..	25	35 — 37	35 — 37	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 (£7 pd.)	10	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>2</sub> — 10	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ... ..	10	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>2</sub> — 10	...	...
38,348	London Platino-Brazilian Telegraph, Limited ... ..	10	6 — 7	6 — 7	...	...
100,000	Do. do. do. 6 p. c. Debentures ... ..	100	105 — 108	105 — 109	108	...
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 £8 pd.	10	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	6 <sup>1</sup> / <sub>2</sub> — 7 <sup>1</sup> / <sub>2</sub>	7 <sup>1</sup> / <sub>2</sub>	7
438,984	National Telephone, Limited, Nos. 1 to 438,984 ... ..	5	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>2</sub> — 4 <sup>3</sup> / <sub>4</sub>	4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>2</sub>
15,000	Do. do. 6 p. c. Cum. 1st Preference ... ..	10	12 <sup>1</sup> / <sub>2</sub> — 12 <sup>3</sup> / <sub>4</sub>	12 <sup>1</sup> / <sub>2</sub> — 12 <sup>3</sup> / <sub>4</sub>	...	...
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9 <sup>1</sup> / <sub>2</sub> — 10 <sup>1</sup> / <sub>2</sub>	9 <sup>1</sup> / <sub>2</sub> — 10 <sup>1</sup> / <sub>2</sub>	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8 <sup>1</sup> / <sub>2</sub> — 9	8 <sup>1</sup> / <sub>2</sub> — 9	8 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub>
9,000	Reuter's, Limited ... ..	8	8 <sup>1</sup> / <sub>2</sub> — 9	8 <sup>1</sup> / <sub>2</sub> — 9	...	...
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	{ 1 }	{ 8 <sup>1</sup> / <sub>2</sub> — 9 }	{ 8 <sup>1</sup> / <sub>2</sub> — 9 }	{ ... }	{ ... }
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	2 <sup>1</sup> / <sub>2</sub> — 3	2 <sup>1</sup> / <sub>2</sub> — 3	...	...
3,381	Submarine Cables Trust ... ..	Cert.	113 — 117	108 — 112	...	...
78,949	Swan United Electric Light, Limited ... (£3 <sup>1</sup> / <sub>2</sub> only paid)	5	4 <sup>1</sup> / <sub>2</sub> — 5 xd	4 <sup>1</sup> / <sub>2</sub> — 5	4 <sup>1</sup> / <sub>16</sub>	4 <sup>1</sup> / <sub>2</sub>
37,350	Telegraph Construction and Maintenance, Limited ... ..	12	43 — 45	43 — 45	44	...
150,000	Do. do. do. 5 p. c. Bonds, red. 1894 ... ..	100	100 — 102	100 — 102	102	...
58,000	United River Plate Telephone, Limited ... ..	5	3 — 4	3 — 4	...	...
146,128	Do. do. 5 p. c. Debenture Stock ... ..	Stock	90 — 94	90 — 95	...	...
3,200	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ... ..	100	...	...	...	...
15,809	West African Telegraph, Limited, Nos. 7,501 to 23,109 ... ..	10	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	8 <sup>1</sup> / <sub>2</sub> — 9 <sup>1</sup> / <sub>2</sub>	9	...
290,900	Do. do. do. 5 p. c. Debentures ... ..	100	98 — 101	98 — 101	...	...
30,000	West Coast of America Telegraph, Limited ... ..	10	4 — 5	3 <sup>1</sup> / <sub>2</sub> — 4 <sup>1</sup> / <sub>2</sub>	...	...
150,000	Do. do. do. 8 p. c. Debs. repay. 1902 ... ..	100	102 — 107	102 — 107	...	...
64,174	Western and Brazilian Telegraph, Limited ... ..	15	10 <sup>1</sup> / <sub>2</sub> — 11 xd	10 <sup>1</sup> / <sub>2</sub> — 11 <sup>1</sup> / <sub>2</sub>	11	10 <sup>3</sup> / <sub>4</sub>
27,873	Do. do. do. 5 p. c. Cum. Preferred ... ..	7 <sup>1</sup> / <sub>2</sub>	6 <sup>1</sup> / <sub>2</sub> — 6 <sup>3</sup> / <sub>4</sub> xd	6 <sup>1</sup> / <sub>2</sub> — 6 <sup>3</sup> / <sub>4</sub>	6 <sup>3</sup> / <sub>4</sub>	6 <sup>1</sup> / <sub>16</sub>
27,873	Do. do. do. 5 p. c. Deferred ... ..	7 <sup>1</sup> / <sub>2</sub>	4 <sup>1</sup> / <sub>2</sub> — 5	4 <sup>1</sup> / <sub>2</sub> — 5	4 <sup>1</sup> / <sub>2</sub>	...
200,000	Do. do. do. 6 p. c. Debentures "A," 1910 ... ..	100	103 — 106	103 — 106	105	103
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106	...	...
88,321	West India and Panama Telegraph, Limited ... ..	10	2 <sup>1</sup> / <sub>2</sub> — 3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>2</sub> — 3	3 <sup>1</sup> / <sub>2</sub>	2 <sup>1</sup> / <sub>16</sub>
34,563	Do. do. do. 6 p. c. 1st Preference ... ..	10	11 <sup>1</sup> / <sub>2</sub> — 11 <sup>3</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>2</sub> — 11 <sup>3</sup> / <sub>4</sub>	11 <sup>3</sup> / <sub>4</sub>	11 <sup>1</sup> / <sub>2</sub>
4,669	Do. do. do. 6 p. c. 2nd Preference ... ..	10	11 — 12	11 — 12	...	...
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125	...	...
175,100	Do. do. do. 6 p. c. Sterling Bonds ... ..	100	99 — 103	99 — 103	...	...
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2 <sup>1</sup> / <sub>2</sub> — 2 <sup>3</sup> / <sub>4</sub>	2 <sup>1</sup> / <sub>2</sub> — 2 <sup>3</sup> / <sub>4</sub>	...	...

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6<sup>1</sup>/<sub>2</sub> paid), 7<sup>1</sup>/<sub>2</sub>—7<sup>3</sup>/<sub>4</sub>.—Elmore Copper Depositing Priorities, 7—7<sup>1</sup>/<sub>2</sub>.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2—2<sup>1</sup>/<sub>2</sub>.—House-to-House Company (£5 paid), 4<sup>1</sup>/<sub>2</sub>—5<sup>1</sup>/<sub>2</sub>.—London Electric Supply Corporation, Ordinary (£5 paid), 1<sup>1</sup>/<sub>2</sub>—2<sup>1</sup>/<sub>2</sub>.—Manchester Edison and Swan Company, £9 (£1 paid) 11/-—13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2<sup>1</sup>/<sub>2</sub>—3<sup>1</sup>/<sub>4</sub>.—Preference, 4<sup>1</sup>/<sub>2</sub>—4<sup>3</sup>/<sub>4</sub>.

BANK RATE OF DISCOUNT.—6 per cent. (7th November 1890).

PROCEEDINGS OF SOCIETIES.

The Institution of Electrical Engineers.

(Continued from page 653.)

Fig.	Position of binding screws.	State of nut and screw T.	Length of lug in inches.	Current in amperes	P.D. in volts.	Resistance in ohms.
7	A and D	...	...	8	0.00187	0.000230
	A and C	...	3.25	8	0.00117	0.000150
	A and B	...	1.5	8	0.00060	0.000070
	T and A	Dirty	Wire pressed on at T	8	0.00038	0.000047
		Clean		8	0.00028	0.000035
		Dirty	Wire screwed on at T	8	0.00028	0.000035
		Clean		8	0.00025	0.000031
8	K and H	...	6.5	8	0.00219	0.000270
	F and H	...	4.0	8	0.00126	0.000160
	G and H	...	1.5	8	0.00049	0.000060
	T and H	Dirty	...	8	0.00021	0.000030
		Clean	...	8	0.00021	0.000030
9	K and L	Dirty	...	8	0.00522	0.000650
	T and O	Dirty	...	8	0.00063	0.000080
		Clean	...	8	0.00057	0.000070
	K and L	Very dirty	13	5	0.00500	0.001000
	T and O	very dirty	...	3	0.00524	0.001750
		Clean	...	10	0.00044	0.000044

From this it appears that the resistance per inch of the lug alone is about 0.000043 ohm; and that the resistance at the contact of two lugs which were tightly screwed together when quite clean, but which have become very dirty from the acid spray falling on them, may be as high as 0.001 ohm, or thirty times the resistance of an inch of the lug itself. The resistance between r and o, fig. 9, being greater than between k and l, when r was very dirty, is probably explained by the fact that when the wire was screwed under r to test the resistance between r and o, fig. 9, it was screwed against an exceptionally dirty bit of the lug.

As we have shown in the Edinburgh paper, the mean resistance from positive lug to negative lug of one of these accumulators complete is about 0.004 ohm when the contacts between the lugs and the testing wires are made quite clean. Hence it appears that about one-seventh of the whole mean resistance of such an accumulator is caused by the resistance of the lead lugs themselves; and that the resistance of such accumulators as we have been experimenting with can, when joined up in series, be increased by 25 per cent. if the contacts be allowed to become dirty by the acid spray falling on them, even although they remain all tightly screwed up.

Since these tests were made we have had all the accumulators disconnected, the contacts carefully cleaned and tightly screwed up, and the nuts and screws then coated with hot paraffin wax.

The coarsely divided paraffined cork which is sold by Messrs. Drake & Gorham for floating on the tops of accumulators to filter the hydrogen gas from sulphuric acid spray, was most successful in stopping the acid fumes from escaping into the room when we first obtained it. As, however, the cork became thoroughly wetted with the liquid, its filtering property was much diminished. It appears to us that there still remains the need for a really good spray arrester.

IV.

ANALYSIS OF PLUGS.

The following is the report of the analyses of the plugs removed at different stages of the charging and discharging, which Mr. Robertson has been so kind as to prepare for us:—

Report by G. H. Robertson on Analyses of Plugs from an E.P.S. Cell made in the Chemical Department of the Central Institution.

16th October, 1890.

Preparation of the samples for analysis:—

The positive samples were taken separately, washed on to filters, and thoroughly freed from acid. In every case the samples from the bottom were harder to wash than the others, and the residues were dried for some hours at about 120° C.

The samples were now ground up fine in an agate mortar, and the splinters of wood and glass removed as far as possible. The approximate weights for analysis were now taken and re-dried on watch glasses at about 140° C.

At first the substance for analysis was dissolved in a porcelain dish, and the insoluble residue of sulphate was filtered off with the intention of determining the amount of sulphate by the ammo-

nium acetate method; but owing to the small amount of material available and the error introduced by the solubility of lead sulphate in the nitric acid used to dissolve the sample, the attempt to determine both the peroxide and the sulphate was abandoned and the samples were used to determine the peroxide only as accurately as possible. This course was justified by the fact that very careful qualitative experiments showed that nothing but peroxide and sulphate was present in the plugs.

The method employed to determine the peroxide was the ammonium oxalate and permanganate method described in Sutton's "Volumetric Analysis," as in previous analyses it had been found very sensitive; and the solutions were checked about every two days against pure lead peroxide, and each day the solutions were run against each other, but they were not found to alter practically in the time they lasted. The first lot of ammonium oxalate was standardised against permanganate which had been very accurately standardised against iron, and by the nitrometer method.

Using this solution, "pure" lead peroxide, as purchased, and which afforded a slight white residue like silica, contained 97.3 per cent. as the mean of a large number of analyses made with different weights; and any subsequent solution which gave the percentage between 97.2 and 97.5, inclusive, was taken as correct. It will be noticed that d and A' gave practically the same percentage as the sample of pure lead peroxide.

The residues from the samples containing the highest percentage of peroxide of lead were white, those from the samples containing the smaller percentage were brownish-white; and it was noticed that if the larger grains were crushed under the end of a glass rod they had a dark centre of peroxide, which at once dissolved, leaving a slight yellowish-white insoluble ring. By grinding the sample very fine in the mortar, so as to break up the capsules of sulphate more thoroughly, the residue was got lighter in colour; and using a flask to boil the substance in, the residue becomes perfectly white: but this yellowish-brown tinge to the sulphate does not seem to be due to any appreciable quantity of undissolved peroxide, as practically identical percentages were obtained with pure white and yellowish residues. Dark residues gave low results.

In the case of the very hard plugs, there was some error from the glass and wood, which could not be picked out altogether, though the samples were picked over very carefully (cf. d', d'', e').

Lead Peroxide Formed on the Positive Plates during Charge.

Percentage of Pb O <sub>2</sub> .	Mean.	Mean increase in percentage Pb O <sub>2</sub> and time interval.	Total Hours Charge.	P.D. in volts just		Specific Gravity of Liquid.
				Before breaking circuit.	After closing circuit.	
A*			H. M.			
Top ... { 30.6 31.0 32.7	31.43					
Middle { 35.23 35.34	35.28	34.5*	0 37	2.134	2.122	1.178
Bottom { 36.5 37.3 36.6	36.80					
B			H.M.			
Top ... 77.0	77.00					
Middle { 76.1 76.8	76.45	75.5	9 48	2.2	2.186	1.198
Bottom { 73.2 73.3	73.25					
C		8.8	1 49			
Top ... 88.0	88.00					
Middle { 85.15 84.72	84.93	84.3	11 37	2.234	2.186	1.201
Bottom { 79.8 80.3	80.05					
D		10.8	2 50			
Top ... { 96.3 96.8	96.5					
Middle { 94.1 93.42	93.76	95.1	14 27	2.4	...	1.206
Bottom { 95.00 95.11	95.05					

\* Only the surface of the positive plugs was removed in the first attempt, A.

Lead Peroxide Reduced on the Positive Plates during Discharge.

Percentage of Pb, O <sub>2</sub> .	Mean.	Mean increase in percentage Pb O <sub>2</sub> , and time interval.	Total hours dis- charge	P.D. in volts just		Specific gravity of liquid.	
				Before breaking circuit.	After closing circuit.		
A'							
Top ... { 96·7 { 97·0	96·85	A	H. M.	1·998	2·002	1·205	
Middle { 94·88 { 94·37	94·62		0 25				
Bottom { 93·4 { 93·1	93·25						
		H.M.					
		31·7 7 27					
B'							
Top ... { 67·5 { 67·06 { 67·0	67·2	V	7 52	1·956	1·958	1·189	
Middle { 64·82 { 64·25	64·53						A
Bottom { 57·9 { 57·7	57·8						
		15·3 4 16					
C'							
Top ... { 49·0 { 48·8 { 48·8 { 48·3	48·7	V	12 8	1·850	1·902	1·180	
Middle { 49·92 { 50·5 { 50·2	50·45						A
Bottom { 44·07 { 44·90	44·48						
		6·5 2 29					
D'							
Top ... { 41·8 { 44·01 { 43·9	43·2	V	14 37	0·6	1·9	1·175	
Middle { 42·70 { 42·92	42·81						A
Bottom { 37·9 { 38·6	38·25						
		5·4 3 26					
E'							
Mixed { 36·6 { 36·7 { 34·8	36·00	V	18 3	Zero E.M.F. indefinite on re-making circuit.		1·172	

For the sake of comparison the percentage of Pb O<sub>2</sub> at A in the following table is taken as 47·9, as at c'.  
The calculations refer to the mean values of Pb O<sub>2</sub>, and the values of the P.D. before breaking circuit.

Charge.	Interval.	Increase per hour in percentage Pb O <sub>2</sub> .	Percentage increase in P.D. in interval.	Percentage Increase in Pb O <sub>2</sub> in interval.
	A to B B to C c to D	3·0 4·8 3·8	3·1 1·6 7·4	27·6 8·8 10·8
Discharge.	Interval.	Decrease per hour in percentage Pb O <sub>2</sub> .	Percentage decrease in P.D. in interval.	Percentage decrease in Pb O <sub>2</sub> . in interval.
	A' to B'	4·3	3·1	31·7
	B' to c'	3·6	5·4	15·3
	c' to d'	2·6	67·4	6·5
	d' to e'	1·6	100 0	5·4

The screening influence of lead sulphate is clearly brought out in this table. Between A and B the surface film and the coatings on the partially reduced granules of Pb O<sub>2</sub> are got rid of; then between B and C the pure lead sulphate is attacked; and finally, between C and D, with the removal of the last traces we get a very rapid rise in volts P.D.

In the case of the negative plates, the sulphate was in such a loose and powdery condition that it fell off and adhered to the insides of the bottles used for receiving the plugs in, and it was quite impossible to obtain representative samples for quantitative analysis; so qualitative tests had to be made, which in the case of charge, showed nothing but sulphate of lead and lead, the sulphate decreasing during charge until at D there was practically nothing but pure lead.  
During discharge the sulphate increased; at c' there was a doubtful indication of peroxide of lead, and at d' and e' there was decided evidence of peroxide. After a few days the plugs were white all over, and there was no difference in appearance between the front and back. The water had no acid reaction.

FIG. 7.

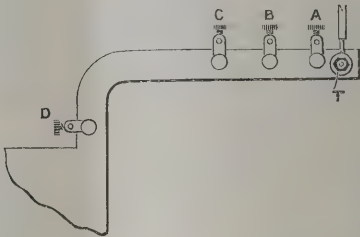


FIG. 8.

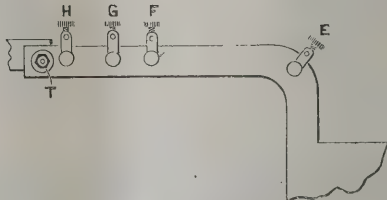
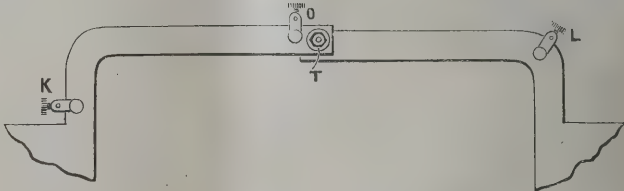


FIG. 9.



It will be observed that :—  
(a.) The particles of the peroxide very soon get coated in the discharge with a layer of lead sulphate, which protects the peroxide from further action, as shown by the examination of the dark-coloured residues which contained peroxide, and which were rendered very hard to dissolve by the coating of sulphate.  
(b.) The analysis also shows what a large proportion of active material is still remaining at the end of the discharge. This has been remarked on by many experimenters.  
(c.) The loose powdery surface of the positive plate seems to be thoroughly converted into lead sulphate. C and B' dissolved readily, leaving pure white residues.  
(d.) When the peroxide in the surface of the plate falls to about 31 per cent. the cell loses its E.M.F. very rapidly, owing to the inactive layer of sulphate impeding the action of the sulphuric acid on the active material behind it, and also to the formation of peroxide on the negatives. The diffusivity of the acid is decreasing, and it has to penetrate further into the plate to find active material. When the whole of the paste approaches this composition of 31 per cent. peroxide, the cell loses its E.M.F. entirely.  
(e.) The action seems to take place most rapidly where the current-density is greatest; the plate gets hard there from sulphate soonest on discharge, and oxidises quickest on charge.  
Planté and Messrs. Gladstone and Tribe have both noticed the formation of peroxide of lead on the negative plate during discharge, and pointed out that once it is formed more rapidly than it is reduced, the two plates must rapidly approach electrical equilibrium; that when the circuit is broken local action alone can take place, and this will reduce the peroxide on the negative plate, and on making the circuit again the cell will again give a current; and in this way Messrs. Gladstone and Tribe account for the resuscitating power of the cell, as well as for the rise of E.M.F. on breaking the discharging circuit.  
I have to acknowledge the facilities afforded me for seeing the plugs as they were removed, and the care taken to let me have the samples in good condition.  
I am also indebted to Professor Armstrong for his invaluable advice and assistance in the execution of the work.  
G. H. ROBERTSON.

From the mean results of the preceding analysis carried out by Mr. Robertson, we have drawn the curves seen in the lower part of figs 1 and 2, and which show the percentage of  $PbO_2$  found in the plugs of the positive plates at all stages of the charge and discharge. In the  $PbO_2$  curve for charge the first point is obtained from the analysis of the plugs at the end of the normal discharge—that is, when the terminal P.D. had fallen to 1.85 volts, indicated by the point  $c'$  in fig 2. The percentage of  $PbO_2$  actually found in the positive plugs at the point indicated by  $A$  (fig. 1) does not lie on the  $PbO_2$  curve as drawn, but, as already indicated, this arises from the specimens removed from the plugs at experiment  $A$  being only scrapings off the surface, and therefore not representing the average constitution of the plugs. On all subsequent occasions when specimens were removed from the plates, whole plugs, as already stated, were detached. The analysis at the point  $A$  (fig. 1) was, therefore, abnormal, and the percentage of  $PbO_2$  obtained for this point, and which is given in the table, is not indicated on the curve.

If the energy given out by the cell be produced by the conversion of  $PbO_2$  in the positive plugs, and of  $Pb$  in the negative, into lead sulphate, a constant value of the P.D. at the terminals of the cell when a constant current is passing through it ought to correspond with a constant rate of variation of the percentage of  $PbO_2$  in the positive plugs; so that for a constant current

$$\text{the terminal P.D. should } \propto \frac{d(PbO_2)}{dt},$$

$t$  representing time. This connection is seen to exist fairly well in the case of the discharge where the slope of the  $PbO_2$  curve is roughly constant as long as the P.D. is constant, and acquires a less inclination to the axis of time when the P.D. is rapidly falling. In the case of the charge, the connection between the value of the P.D. and the slope of the  $PbO_2$  curve is not so easily seen; but this arises from the fact that towards the end of the charging there is a rapid rise in the resistance of a cell, and therefore in the P.D. required to send a constant current through it; further, the back E.M.F. steadily increases during charging on account of the polarisation, which grows larger and larger from the continuous evolution of gas at the surface of the plates.

(To be continued.)

## NEW PATENTS—1890.

17580. "Improvements in the decorative arrangement of electric lights." J. M. M. MUNEO. Dated November 3.

17589. "Improved means for lighting street gas lamps by electric spark." C. BARNETT. Dated November 3.

17600. "An electrical switch for opening and closing of circuits, switching on currents, and so forth." A. C. LAINCHBURY. Dated November 3.

17611. "Improved electrical push-button for signalling circuits." C. D. ABEL. (Communicated by H. Messing, Germany.) Dated November 3.

17631. "Improvements in or relating to electric accumulators." P. LAUBER. Dated November 3.

17674. "Incandescent gas lights." C. M. LUNGREN. Dated November 4. (Complete.)

17690. "Method of and apparatus for obtaining electricity by hydraulic power." C. A. RANDALL. Dated December 4.

17711. "Improvements in means for the distribution of electricity." H. EDMUNDS. Dated November 4.

17716. "Improvements in and relating to machines for covering wire." H. H. LAKE. (Communicated by the New England Butt Company, United States.) Dated November 4. (Complete.)

17728. "Improvements in electric railways." M. W. DEWEY. Dated November 4. (Complete.)

17829. "Improvement in incandescent lampholders or suspenders." J. E. CHARNOCK. (Communicated by C. Charnock, Russia.) Dated November 6.

17851. "Improvements in electric thermostats for ships' bunkers, refrigerating rooms, and other purposes." H. BINKO. Dated November 6.

17852. "Improvements in magneto generators for signalling or medical purposes." H. BINKO. Dated November 6.

17861. "Improvements in the manufacture of electrical conductors and electrodes, and for connecting them, and for analogous purposes." J. MARX. Dated November 6.

17863. "Improvements in portable electric lamps." M. P. HARDT. Dated November 6.

17899. "An improved self-locking electric switch." W. LOWNDS, E. EMANUEL and J. WOOD. Dated November 7.

17905. "An induction transformer coil, and methods of using the same for telephone call bells and other purposes." C. T. B. BRAIN. Dated November 7.

17912. "An electricity meter." J. T. BOTTOMLEY. Dated November 7.

17919. "Improvements in electric energy meters." R. J. F. MOSTYN. Dated November 7.

17929. "Improvements in or connected with armatures for dynamo-electric machines." B. REJCHMAN. Dated November 7.

17937. "Improvements in and relating to electric lamps or lighting apparatus." F. V. MAQUAIRE. Dated November 7.

17940. "Improvements in arc lamps." SIEMENS BROTHERS AND CO., LTD. (Communicated by Siemens and Halske, Germany.) Dated November 7.

17941. "Improved means for charging accumulator batteries on electric circuits supplied by current generators." SIEMENS BROTHERS & CO., LTD. (Communicated by Siemens & Halske, Germany.) Dated November 7.

17951. "Improvements in electric switches." H. H. LAKE. (Communicated by F. C. Jenkins, Germany.) Dated November 7.

17954. "Improvements in electrical accumulators or storage batteries." H. L. MAUGRAS. Dated November 7.

17976. "Improvements in means for firing ordnance charges by electricity." G. QUICK. Dated November 8.

17987. "Improvements in electro-medical appliances." W. R. VARNEY. Dated November 8.

18034. "An improved electric switch." G. F. REDFERN. (Communicated by A. Schirner, Germany.) Dated November 8. (Complete.)

18076. "Improvements in sockets or holders for incandescent lamps." J. Y. JOHNSON. (Communicated by J. W. Collier, United States.) (Complete.) Dated November 10.

18088. "Apparatus to be employed at telephonic switchboards." J. E. KINGSBURY. (Communicated by The Western Electric Company, United States.) Dated November 10.

18103. "Improvements in electric switches." C. E. KNOWLES. Dated November 11.

18158. "An improved electric pressure indicator." C. H. GRAY. Dated November 11.

18163. "An appliance for the administration of electricity to the human body in Turkish baths." M. HUMM. Dated November 11.

18186. "Improvements in electrical measuring instruments." H. H. LAKE. (Communicated by E. Weston, United States.) Dated November 11. (Complete.)

18195. "Improvements in telephonic apparatus for minimising or overcoming inductive and other undesired electrical disturbances in telephonic circuits." A. E. COTTERELL. Dated November 11.

18206. "Improved commutator for dynamo-electric generators and motors." H. DAVIS and A. H. STOKES. Dated November 12.

18217. "Improved protector for telegraph, telephone and other electric instruments." D. MACLEAN. Dated November 12.

18220. "Improvements in connecting electric lamps and apparatus to leads." W. ALLEN and O. V. THOMAS. Dated November 12.

18247. "Improvements in fittings for electric lamps and their conductors." J. D. F. ANDREWS. Dated November 12. (Complete.)

18266. "Improvements in electric tramways and electric conduits." H. J. DAVIES and L. B. S. DUTSON. Dated November 13. (Complete.)

18292. "Improvements in switches for electrical purposes." B. M. DRAKE and J. M. GORHAM. Dated November 13. (Complete.)

18409. "The improvement of electrical switches and other electrical apparatus." L. A. DAVIES. Dated November 15.

18412. "Improvements in electric batteries and lighters for cigars and other purposes." D. ROBERTSON. Dated November 15. (Complete.)

## ABSTRACTS

### OF PUBLISHED SPECIFICATIONS 1890.

350. "Improvements in the formation of electrodes for use in primary and secondary electric batteries." L. EPSTEIN. Dated January 8. 8d. Consists in dividing the process of manufacturing the electrodes into two separate parts, the first part being limited to the making of so-called raw electrodes, which are then transformed into positive electrodes, with the assistance of an electric current in an electrolyte, containing either diluted sulphuric acid, or a suitable salt of sulphuric acid, while the negative electrodes are formed by a reduction of the positive electrodes. 7 claims.

2199. "Improvements in cores and armatures for electro-magnets, solenoids, and the like." S. C. C. CURRIE. Dated February 11. 4d. Consists, firstly, in providing a core or armature of a compact mass of iron in granular form, such as iron chips, filings, or shavings, as described; consists, secondly, of a core or armature formed by mixing or combining with iron filings, chips, or shavings, an insulating substance or material in a granular or liquid condition, and then causing the same, after being subjected to pressure and drying, to assume a compact mass; and consists, thirdly, of a core or armature formed by mixing or combining with iron filings, chips, or shavings, an insulating substance or material as silicate of soda, in a granulated or finely divided state or condition. 10 claims.

2234. "Improvements in electro-mechanical movements, chiefly designed for regulating the carbons in electric arc lamps, and for similar purposes." S. E. NUTTING. Dated February 11. 8d. The object of this invention is to make an electro-mechanical

movement that will be proportioned at all times and under all circumstances to the quantity of the electric current, varying with every variation in the quantity of such current. 5 claims.

2464. "Improvements in electric light fittings." C. M. DORMAN and R. A. SMITH. Dated February 15. 6d. Consists partly of forming the metallic terminals of the lampholder and ceiling plate with a projecting hook round which the wire conveying current can be twisted; the weight of the fitting is then borne by these hooks instead of by the terminal screws. Also consists in using a novel form of spiral spring nut by which the reflector or shade is held on to the lampholder. Also consists in forming an independent cord-grip arrangement in the cover of the ceiling plate, consisting of a screwed nozzle through which the wires pass, which nozzle, when screwed home, squeezes the wires, which are led one on each side of a loose disc between the nozzle and the cover of the ceiling plate. 5 claims.

2621. "Improvements in electrically driven fans." H. G. WATEL. Dated February 18. 6d. Consists in applying the electrical driving near the centre of the fan, accommodating the electro-dynamic apparatus within a hollow boss. 1 claim.

2825. "Improvements in bases, covers, and fixings for electrical safety fuses, switches, and the like." W. WHITE. Dated February 21. 6d. Relates to means of making attachments and fixings to ceramic material.

2957. "Improvements in electric counters or apparatus for ascertaining and registering the duration of the passage of an electric current." J. J. A. AUBERT. Dated February 24. 6d. Consists of a clockwork movement, the pendulum of which is governed by an electro-magnet or a solenoid, which is in communication with the conductor of electricity. When the current passes, the clockwork movement is put in motion, but when the current is interrupted the pendulum encounters an obstacle which stops the clockwork. If the face of the clockwork is provided with a suitable scale and pointers, the exact time during which an electric current has passed will thus be registered. 3 claims.

3024. "Improvements in electric-motors." H. H. LAKE. (Communicated from abroad by E. B. Parkhurst, of America.) Dated February 25. 11d. Comprises multiple magnets or coils in the field and armature, one or both of which are revolved, and groups of magnets or coils in the armature are successively caused to act in conjunction with groups of magnets or coils in the field, when the respective poles of the groups of magnets or coils are so related to each other as to produce a maximum result from the current employed. 7 claims.

3924. "Improvements in electric Batteries." H. H. LAKE. (Communicated from abroad by the Crosby Electric Company, of New York.) Dated March 12. 6d. Consists in certain novel features, the object being to produce a simpler, cheaper, and more effective device than is now in ordinary use. 4 claims.

## THE FRENCH TELEGRAPH AND TELEPHONE BUDGET.

THE discussion on the above portion of the French Budget was sufficiently acrimonious, but if possible our Parisian contemporaries' comments were more so. To take one, for instance: The discussion on the Budget of Posts and Telegraphs permitted the Chamber to clearly manifest its approbation for the system set forth by M. de Lanessan and some others, a system which consists in treating the postal service as a well administered service, that is to say, in reserving a small portion of its profits to improve the position of its staff and develop its material, in obedience to the growing requirements of the traffic. From the new studies to which the Government and the Budget Commission have undertaken, a new scheme has come forth, which the commission defends to-day before the Chamber, and which increases by 2,200,000 francs in receipts and expenses the postal budget of 1891. The 2,200,000 francs of expenses are composed as follows: At Paris, creation of two new offices and the employment of 100 postmen; and for the departments, among other things, the creation of 100 *petits télégraphistes*, unification of the kilometric indemnity of telegraph messengers to 7½ centimes; creation of telegraph offices, prolongation of the daily service in 13 offices, the establishment of 1,000 kilomètres of new wire, and an increase of 1,415,000 francs in the payment of the staff. But the sum of 2,200,000 francs only applies to the year 1891. The Minister himself declares that in order to carry out the programme of improvements necessary, much greater expenses will have to be met. He will set them forth in the budget project for 1892, which will shortly be laid on the table. Where are the 2,200,000

francs to be found for 1891? The Government and the commission propose to find them as follows: In the first place, they alter Article 6 of the law of April 5th, 1879, so as to place a tax of 0.10 on valuables of all kinds confided to the Post Office for recovery and remaining unpaid. Then they alter Article 5 of the law of April 6th, 1878, in such a way as to raise by 0.1 the tax on all printed matter over 20 grammes (other than electoral circulars, voting bulletins, newspapers, and periodical publications). The tax would thus be 0.02 up to 5 grammes, 0.03 from 5 to 10 grammes, 0.04 from 10 to 15 grammes, 0.05 from 15 to 50 grammes. To these proposals two amendments were presented. M. Mir asked that the expense should be raised to 2,500,000 francs, so that 300,000 francs might be given to the ambulant service.

M. Leydet wished to have the expenses raised to 3,000,000 francs, thus providing 300,000 francs for the ambulants, 100,000 francs for the principal receiving office, and 400,000 francs for the Parisian Telegraphic Service. But the authors of the amendments, while increasing the expenses, do not approve the measures proposed for the receipts. They regarded them as new taxes, and fatal on industry and commerce. It was from the profits of the working that they wished to deduct the cost of the improvements. M. Peytral, on the other hand, contended that before voting increased expenses, it would be necessary to ratify the increase of the correlative receipts. This objection, however, did not hold, and the President of the Budget Commission easily defeated it, because, at all times, Parliaments have voted public expenses before establishing taxes to meet them. On the contrary, the State determines its needs before knowing its resources. The Mir and Peytral amendments were rejected by 316 votes against 182 votes, and the expenses proposition of the Commission adopted. An amendment by M. Poulié, proposing an increase of 20,000 francs for the transformation of some single offices into compound, was also rejected. Regarding Corsica, M. de Douville-Mailefen informed us that while the postal service between Dover and Calais worked admirably for 100,000 francs per year, that between Nice and Corsica cost 350,000 francs, and worked when it pleased the concessionaires.

The Telephone Budget was voted without any observations of interest.

## CORRESPONDENCE.

### Electro-Deposition of Copper: Misconceptions and Fundamental Laws.

I notice that your contemporary, the New York *Electrical Engineer*, in its issue of the 12th ult., gives a leader in which it professes to "set at rights" certain "obvious miscalculations" put forward editorially in your paper. Without particularly referring to the degree of success with which its proposed task has been accomplished, I may perhaps be allowed to say, generally, that the article in question, and also certain passages in your own correspondence columns, suggest the prevalence of misconceptions which may perhaps be entirely removable by a simple reference to some of the fundamental laws of electrolysis.

One of these misconceptions (a) is that it is not permissible to assume, in the abstract consideration of a given case of electro-deposition, that the operation is carried on in one tank, instead of in several or many tanks, having in the aggregate the same extent of anode and cathode surface.

Another misconception (b) is that it is unjustifiable, because necessarily unfair and detrimental to a process for the electro-deposition of copper, to assume in a given case that the action takes place under a potential difference of one volt.

A third misconception ( $a_1$ ), which is involved in (a),

is that a current of (say) 3,000 ampères, depositing a given mass of copper in a given time, must necessarily give a result superior in point of economy to that obtained with a current of (say) 110,625 ampères depositing the same mass of copper in the same time.

It would, of course, be a very grave misconception to suppose that any results at variance with the well-understood fundamental laws and quantitative data of electrolysis can be obtained in practice.

The fundamental expression for electrical energy or work is

$$Q E,$$

in which  $Q$  is quantity of electricity and  $E$  electromotive force.

To dissolve and to deposit electrolytically a given mass of copper, some amount of electrical energy is required, and must be expended in performing electrical work. This amount of energy, however, is variable within wide limits. The main object of the art of electro-deposition is to determine in practice what amount of electrical energy it is most profitable to expend in producing a given result, *e.g.*, in depositing the given mass of copper.

The above expression for electrical energy may conveniently be rendered as

$$C E \theta,$$

in which  $C$  is current and  $\theta$  time.

Now although this value, as a whole, bears no definite relation to a given mass of (say) copper to be deposited, it involves one product, *viz.*,  $C \theta = Q$ , which, in the case of one depositing cell or tank, or any number of cells or tanks in parallel, is absolutely definite and constant in relation to the given mass. This fact is expressed in the statement that if  $C = 1$  ampère, and  $\theta = 1$  second, the mass of copper deposited will be neither more nor less than .0050478 grain.

It may here be observed that, in circuits containing no counter-electromotive force, the above value,  $C E \theta$ , may be equated to :

$$C^2 R \theta = \frac{E^2}{R} \theta,$$

where  $R$  is the resistance of the circuit.

But, in the contrary case, when  $E$  is opposed by a back electromotive force,  $E_1$ , the total energy expended is expressed by  $C E \theta$ , whilst  $C^2 R \theta$  represents the energy converted into heat, and  $C E \theta - C^2 R \theta =$

$$C E_1 \theta = \frac{E_1^2}{R_1} \theta \quad (\text{where } R_1 \text{ is the resistance associated}$$

with  $E_1$ ), represents the energy rendered potential in the products of the electrolysis. And it may further be observed that in the case of copper dissolved from and deposited upon copper, the back E.M.F. is so inconsiderable, at least when electro-deposition takes place under a potential difference approaching 1 volt, that the circuit may, practically, be considered as one in which

$$C E \theta = C^2 R \theta = \frac{E^2}{R} \theta.$$

Now, suppose we have to consider a given case of electro-deposition in the abstract—to obtain some idea of the power, time and *matériel* which would be requisite to carry it into effect, under conditions susceptible of being modified according to the requirements of practice; the first thing we have to do is to determine the value  $C \theta = Q$ , which is dependent solely upon the nature and upon the mass, or weight, of metal to be dissolved and deposited. If time be given or assumed, we have only to calculate  $C$  from the datum given above. Now  $C$  is the current necessary to deposit, in the time  $\theta$ , the given weight of metal in one depositing cell or tank. Technically, this expression may mean any number ( $n$ ) of tanks, provided they are connected, not in series, but in parallel. Of course we are bound to assume the simplest conditions; nor is it necessary, as I will now show, to assume any other. If, instead of one cell or tank, there be  $n$  cells or tanks in parallel, these cells being similar to each other, and equivalent in the aggregate to the single cell assumed, then, of course, the current through any one of these will be

$c = \frac{C}{n}$  or  $n c = C$ . And if the  $n$  cells be arranged in series, exactly the same conditions will prevail; the current in any one of them will be  $c = \frac{C}{n}$ . In a concrete case this statement would not be accurate, because the dynamo giving the current would be constructed with a certain resistance, and to give a certain E.M.F. In such a case, it might be advantageous to arrange the tanks in multiple arc, or to connect them in series. M. Gramme, in his well-known experiments, found it advantageous to connect the tanks in series, simply because the dynamo he used was not one of low resistance. In our abstract consideration we are not tied, so far, to any stated E.M.F., or resistance outside of the depositing tanks; and it is absolutely indifferent, therefore, whether we determine to connect the tanks in parallel or in series. We can now obtain dynamos of very low resistance and economical in working, which was not the case at the period of M. Gramme's experiments. But even if this were not the case, it is not only allowable to assume the simplest conditions—that of a real or suppositious single tank—but it is not permissible to do otherwise in the absence of concrete data. Only an outsider would suppose for a moment that our data in relation to a single tank, from which other data can readily be obtained, were intended to imply, in case of extended operations, the construction of an enormous reservoir.

Our next step, to enable us to determine the energy to be expended in depositing the given mass of metal, is to fix a value for  $E$ . This value, in our abstract view, should be the potential difference of the electrodes in a single cell. Note that we have already determined  $C$ , which is the *ratio* of  $E$  to  $R$ . If in our equation we over-estimate  $E$ , from the point of view of economical working, we also in this equation over-estimate  $R$ . Thus, before anyone can fairly complain that too high a value has been assumed for  $E$ , he must have arrived at the conclusion that the corresponding

value for tank resistance ( $R$ ), *viz.*,  $\frac{E^2 \theta}{W} = \frac{W}{C^2 \theta}$ , is too

high for economical working, and that more capital should be invested in tank plant, and less money expended in electrical energy, than are indicated in the equation arrived at. In the case of a process in which the strong point is low tank resistance, a high value of  $E$  and of  $R$  might advantageously be challenged on the score of economy; but when the weak point of a process is high tank resistance (*vide* the penultimate paragraph in my letter on page 572), the suggestion of a high value for  $E$  might be unfair only in the sense of unduly favouring the process in question.

Having arrived at a value,  $W = C E \theta$ , applicable in the case of a single tank, or in that of the equivalent  $n$  tanks in parallel, we have data so readily applicable to the case in which the  $n$  tanks are in series that it is not necessary in general to specially refer to this case. The resistance of the "single tank" being  $R$ , that of each of the  $n$  tanks will of course be  $n R$ , and that of the  $n$  tanks in series will be  $n^2 R$ . Now to obtain the original current passing between unit anode and cathode surface, we require a potential difference equal to  $E$  acting over each tank, or  $n E$  for the  $n$  tanks in series. This current

will obviously be  $c = \frac{n E}{n^2 R} = \frac{E}{n R}$ , and the electrical en-

ergy expended in the time  $\theta$  will be  $n E \times \frac{E}{n R} \theta = \frac{E^2}{R} \theta$

$= C E \theta$ , as before. To assume that there is essentially

any advantage in reducing the current from  $C$  to  $\frac{C}{n}$ ,

when the electromotive force is augmented from  $E$  to  $n E$ , and that the mere indication of this reduction of the current is a crushing rejoinder to those who may calculate current on the "single tank" basis is a misconception, that to be refuted needs only to be pointed out.

Desmond G. FitzGerald.

### Telephone and Telegraph Construction—A Pole for Many Angles.

As I have not seen nor heard during my 20 years' experience in telegraph construction of a really good improvement in the arming of poles for positions where the angles, acute or obtuse, cannot easily be avoided, I beg to submit a rough sketch of a novel arrangement which may be useful to, and improved by, electrical engineers.

The objects and advantages are as follows, viz. :—

1. To dispense with G.P. cross connections and to admit of the line wires being run through in a similar manner to the ordinary poles.
2. To lessen complications on terminal poles.
3. To suit all, or many, angles by simply fitting the arms on the iron supports to face the pole on each side of the span.
4. To keep the wires the same distance apart as the holes in the arms, and thereby lessen the risk of contacts in stormy weather, &c.

A square pole, or two round poles fitted together in the form of the letter A or H, might be employed to

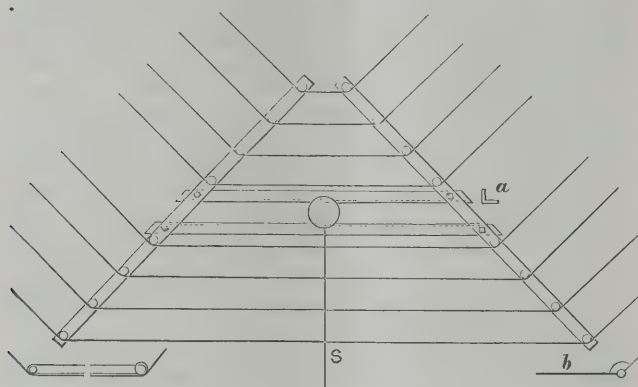


FIG. 3.

FIG. 1.

FIG. 2.

Scale  $\frac{1}{4}$  in. = 1 foot.

a, Section of iron; b, Thick wire to act as stay; s, Stay.

advantage in exposed positions. It would be advisable to terminate all the wires as shown by fig. 2 (the groove will admit of this in many cases) on account of the undue strain at the insulators, and to have two inner wires at both ends of the arms of a larger gauge to act as a brace; or the arrangement shown by fig. 3 might be preferable.

When the pole is to act as a terminal pole the arms would of course be braced together in a similar manner to fig. 2, but, say, under the shoulder of the insulator bolt.

I will say nothing about staying, but simply show a stay.

A. I. E. E.

November 26th, 1890.

### Improvements in Telephone Switchboards.

With your permission I will reply to the letter of the Telegraph Manufacturing Company in yesterday's REVIEW.

In my communication which you published on October 31st, I showed that the advantages claimed, including the supposed saving of 30 per cent. in operating, did not exist, but that on the contrary there was a loss, though I did not presume to define it in percentages, the careless use of which on mere estimates should be discouraged. But recognising, as I do, the many considerations which may determine the type of switchboard to be adopted, I assumed there might be some advantages not stated in the original article. In the letter now under reply, those advantages are stated to be accessibility for adjustment and repair, and certainty of action of the indicator drops.

The most delicate parts of a switchboard are the indicator drops. The illustrations on page 488 (October 24th) show the drops in front with three rows of plugs behind them. The back view (fig. 2) shows the cords between the mechanic and the drops. In the board shown in my article the drops are within a few

inches of the mechanic, and there is no obstruction whatever in the way. In this respect, therefore, the exact contrary must be read. The "improved" boards in the most vital part are not more accessible, but less so. But too much importance must not be attached to this. The inaccessibility is not a serious drawback; it might well be submitted to if an increase in facility of operating is thereby attained, but there is no such increased facility.

The "certainty of action of the indicator drops" must be limited by the remarks in the original description, in which it was stated that they were "found to act perfectly well for all telephone lines of ordinary length"—a limitation which is not usually considered an advantage, any more than a reduction of their sensitiveness contributes to increasing the certainty of their action.

The letter further says that I have fallen into the error of assuming that the board shown is the only pattern made. That is not so. The description stated that the board was a standard pattern for any number of lines from 25 up to 150. I took this to mean that an exchange starting with 25 lines would put in a 30-line board, which would form a convenient unit for additions up to 150. This meaning appears clearly from my words, "by the time the exchange had reached." I see that the words in the original description are capable of another reading, but my error arises from having reasonable conditions in mind. The modification changes the ground, but, unfortunately, this is one of those subjects which will not permit one to change one's ground without encountering a further set of conditions for consideration. A unit of 30 is small, but one of 150 is larger than is generally considered economical for small exchanges. To add smaller boards which do not match the first does not commend itself, and to change complete switchboards of small number for complete switchboards of a larger number as the subscribers increase, though possible to large companies with a number of exchanges, is expensive, and more serious to smaller companies whose exchanges are limited in number, or distant from each other.

Then the letter states that if the small pattern annunciators are adopted, "the s. c. board will be quite as compact" as that illustrated in my article. I enclose photograph of several "s. c. boards," on inspection of which you will doubtless appreciate the remark I made, but which the Telegraph Manufacturing Company overlook. I wrote: "I would like to point out that it is not necessary to cover so large a space. The boards may be more compressed, but then the plugs are crowded. It is a choice of evils." The photograph shows 50-line boards of the same width as the 100-line board illustrated October 31st, except that the framework is narrower, they are thus about one-half as compact. To appreciate what equal compactness means, it is only necessary to refer to the illustration, page 523 (October 31st), and add to the 40 plugs there shown 60 other plugs.

I do not see that there is any necessity to "assume" the correctness of the lists of movements I gave. Mine is correct. The other is taken verbatim from the full description of the "improved" board. Comparison is made between the similar number of movements on the one board with speaking keys, and the other without, as if there were still some advantage in that. But it is the absence of these keys (or their equivalent) which is the cause of the clumsy working which I pointed out. More especially is this the case when the operations are carried beyond the mere connecting and disconnecting, which is as far as the comparison has yet gone. The extra plugs and their attachments which become necessary on the "improved" board (which works badly) are more expensive in first cost and maintenance than the speaking keys on the other board (which works well).

Then, with regard to the single-cord boards with speaking keys, allowing four movements in all, which are compared with the board giving seven movements. The Exchanges at Dewsbury and Greenock since August, 1888, and Blackburn since March, 1889 (I

omit instances of earlier date in other countries), have been provided with single-cord boards necessitating only four movements. The principle is well known to telephone engineers, and has been the subject of very able criticisms and reports, which have been published. A 200-line board is about 6 feet long. I am not aware that any other than multiple boards have been made upon this plan, but as the greater includes the less, it could be done if it were considered desirable. Taking the basis of equal compactness with the board on page 523, it is only necessary to add 60 more plugs to the 40 that are there, and 80 more speaking keys (or their equivalent) to the 20 that are there, and one of the reasons why it has not been done may become apparent. Supposing such a board to be made, what becomes of the simplicity and accessibility, not to mention economy, which are rightly (within reason) taken as desirable attributes of switchboards for small exchanges?

It would be affectation for me to overlook that some inference is intended to be conveyed by the reference to my communication as "criticisms by the Western Electric Company through Mr. Kingsbury." If it is intended to be implied that I sent to you, under my own name, a communication which had been prepared by others, you will perhaps permit me to say that the implication is both incorrect and unnecessary.

I am not authorised to criticise on behalf of my company, nor do I wish my remarks to bear the importance which the well-known experience of the Western Electric Company gives to their opinions on this and kindred subjects. I may say further that, in sending you a communication on a subject of general interest, it was not my intention either to advertise my own Company's manufactures or decry those of others. I have throughout confined my criticisms to the particular type of board described on October 24th, which may be manufactured by anybody who cares to take the responsibility of recommending its use, or whose customers in possession of all the information on the subject prefer to have it.

Descriptions communicated to the press are open to public criticism, and the area of critics should include all who can contribute useful information. To criticise on frivolous grounds is objectionable, but in glaring instances of a misleading character, it becomes a duty, especially so in the case of a subject which needs something more than superficial observation. Since the publication of the Telegraph Manufacturing Company's letter, there is no room for doubt that my criticisms were fair and accurate, in which case their origin, though it was frankly stated, is not material.

I do not know that I should have troubled you with those criticisms, but for the fact that I found the enduring work of far-sighted pioneers (some of whom are friends of mine) slightly referred to in comparison with a supposed improvement, the claims of which I examined. I thought the result of my examination of sufficient interest to send to you.

I am sorry this letter is so long. Unfortunately, it takes a long letter to correct the errors of statement and suggestion which may be crowded into a short one.

J. E. Kingsbury.

November 29th, 1890.

P.S.—Will you kindly note I have reverted to the original title. I do so because there are single cord boards and single cord boards.

#### Electric Light on Shipboard.

It must be gratifying to electrical engineers engaged in ship-lighting work to find that the matter is receiving the attention of the Institute of London Underwriters, and other authorities. It must be admitted by those engaged in the work that it was high time some uniform rules or regulations on the subject existed, and also that electric light installations on shipboard should come under survey and inspection; cheap and nasty installations would then be the exception instead of being almost the rule they are at present; and this

survey or inspection should not only be made on the completion of the installation but also at intervals thereafter. It is quite commonly the case to find some years after a ship has been fitted out that numbers of the lights have been shifted, new branches have been made in the wires, old ones left in connection, fuses rendered useless, being connected across by heavy wires and so on. These changes are mostly made by the engineers on board without the assistance or advice of any skilled electrician; consequently sometimes faults are introduced into what was at first a good installation. The inspection of all the fuses on board and of any new wires run in, or old ones disused, should be made frequently.

It seems to be imagined that the single-wire system is more likely to influence the compasses than the double-wire system: quite naturally one would think so, but practically it is such an easy matter to avoid any action on the compasses, that there in reality can be no preference for the one system over the other on that score. The compasses are fixed in certain positions; in almost every case far removed from the main single wires, and it is always arranged (or at least it ought to be) to have a main branch pass on either side of the compass, or run the branch near the compass double-wired. In every single-wired ship there are many places where double wires are run; no ship is entirely single-wired.

In so far as the danger to the compasses from magnetic leakage from the dynamos exists, it is equally the same whether the ship is double or single-wired.

The weak-spots in any ship installation are the joints (always granted, of course, that good wires are used throughout). In a ship with 300 lights, double-wired, there will be probably about 700 soldered joints, that means about 700 points in wiring where the original insulation is cut off and re-insulated by the workmen. Another weakness in double-wired ships lies in the fittings. In these double contact fittings two wires are pulled through, and connected to the holders by screws. In these fittings the wires may make contact with the fitting, or with each other.

In single wiring we have the advantages arising from the fewer joints and less total length of main wires required, and also the advantages of using single wired fittings end central contact holders, these being much safer than double wire fittings and double contact holders.

In a double-wired\* ship having 300 lights, there shall be about half the total length of wire and about half the number of joints. Now it is much easier maintaining the shorter wire in good order, and what is of greater importance, we can spend twice the amount of money on the insulation of the wire per yard, and we can spend twice the amount of money in making each joint. The making of thoroughly water-tight, reliable joints in a high-class insulated wire is a job one very seldom sees; it requires some skill, and therefore has to be paid for. The contractor who puts in single wiring can afford to put skill into his joints and first class wires and insulation into his installations; and, after all, these two points are the important ones in a ship installation—first class insulated wires and skillfully made joints—and, generally speaking, the less wire and fewer joints the better.

As to the accidents which sometimes occur, and *very nearly* originate a fire, these may arise from many causes on board a ship, quite apart from the nature of the wiring, that these cases have been made the occasion for making comparisons between English and American practice in American journals is to be regretted; but since they have been made, I may refer to them here. In the first place, the Americans are not a shipbuilding people, and have not had great opportunities of gaining experience in ship-lighting. I have seen their electric light wires and wiring, and on comparing them with the products of our leading makers on this side, come to the conclusion that we are consi-

\* This seems to contradict the previous par.; should it not read single-wired? —EDS. *ELEC. REV.*

derably better off than they are. A wire equal to the best of our vulcanised rubber insulated wires is not to be got on the other side. The lead-covered wire *without a continuous insulation* of vulcanised rubber is a failure on board ship. Sea water is certain to get in between the wire and the lead pipe where there is no rubber insulation. In fact, if it were not for their high import duty, it would be better for American contractors to import their wires for ship-lighting.

There are scores of large ships single-wired, which have been crossing and recrossing the Atlantic in all weathers, some of them to my knowledge for six years, without either a derangement of the compass or an approach to a fire, and I have no doubt that Messrs. Siemens Brothers could give many instances of single-wired ships fitted by them years ago, in which not the slightest trouble has occurred. And, simply on the score of safety, many of the petroleum ships are single-wired. I know of eight or ten of them which have been running with single wiring for three years past without trouble.

Rankin Kennedy.

#### Polarising Conditions in a Galvanic Battery.

On reading an article by Prof. Dolbear which appeared in the ELECTRICAL REVIEW of the 14th November, I was much struck by some statements he made, because they are in direct opposition to what I have been led to consider—on the authority of one of our ablest electricians—to be the fundamental laws of voltaic electricity.

Prof. Dolbear says in his article, "When a piece of zinc is immersed in water it is found to be electrified, and its potential may be measured by a suitable electrometer;" and again, further on, "When a piece of carbon, or copper, or other element is placed in water, it exhibits similar electrical property." Now, is this the case? For is it not to "Volta" that we owe the discovery of a potential difference being set up, "at the point of contact," of two dissimilar metals?"

Surely, then, it follows from this, that by immersing either of the metals singly or together (but in this latter case not touching or connected in any way other than by the liquid), no potential difference is set up. At least, none adequate enough to account for the E.M.F. of the couple. When, however, one of these is brought into contact with the other, or with "any" dissimilar metal, *e.g.*, a gold ring, then a potential difference is immediately established. Being at present a young electrician, I am merely anxious to know how to reconcile these two diverse views, and I should be very glad if any of your readers would kindly inform me.

A. E. Gosset-Tanner.

November 29th, 1890.

[There is a considerable difference of opinion as to the real seat of electromotive force in the galvanic cell, but a single metal in contact with a liquid becomes polarised. "When a single metal is placed in contact with an electrolyte, a definite difference of potential is produced between the liquid and the metal. If zinc be plunged into water the zinc becomes negative, the water positive. Copper plunged into water also becomes negative, but much less so than zinc." (Jenkin's "Electricity and Magnetism," page 44.) We recommend you to study Chapter II. on "Potential," of Jenkin's book, from which the foregoing extract is taken.—EDS. ELEC. REV.].

#### Notes on Electric Lighting from Central Stations.

Herewith I enclose you for publication copy of letter received by me last week, dealing with statements made in my paper read before the Liverpool Engineering Society.

In putting this before you, I make no comment on the ideas held by the officials of the Silvertown Company, beyond that the data given by me was obtained on the spot, and that in each case I did my best

to verify the statements attributed to me. We are all well aware of the success attending the underground system at Hastings, and it certainly reflects great credit, not only on the manufacturer of the cables in use there, but also on the engineers of the station, Mr. Mercer and his colleagues, that such exemption from troubles on the line has been obtained. With reference to high tension cables, I see no reason why cables insulated with material other than vulcanised rubber should not be equally fit to withstand the stresses brought to bear on the dielectric, and have reliable data to the effect that Messrs. Felten and Guillaume have had some cables of special make under 10,000 volts for some time with perfect success. The Fowler-Waring Company are perfectly able to reply to any remark passed on their manufactures.

In reply to the Silvertown Company's query as to Callender cables, I simply stated that the Liverpool mains under the low tension in use here have proved most successful, and have, under adverse circumstances, maintained their high insulation. I am informed that at Batu a length of over five miles of Callender main has tested up to 50 megohms, and withstands easily 2,000 volts. I prefer to allow the engineers of the Liverpool Company to make more definite statements.

Charles H. Yeaman.

December 1st, 1890.

[COPY.]

The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited, 54, Castle Street, Liverpool,  
27th November, 1890.

C. H. Yeaman, Esq., Liverpool.

Dear Sir,—We are instructed by our London house to draw your attention to an article in the ELECTRICAL REVIEW, dated 21st inst., entitled "Notes on Central Station Electric Lighting," being a paper read by you in January last, before the Liverpool Engineering Society.

We have to point out that certain statements made therein are inaccurate. We are not asking that you should correct these publicly, but we write you that there may be no misunderstanding in future.

You only refer occasionally in the paper mentioned to underground cables, but in three of your references you are wrong.

In the first you say that all underground cables at Hastings are G.P. covered. About one-half are vulcanised rubber insulated cables supplied by us, and we understand that all future extensions will be carried out with this type of our Silvertown cable.

The Hastings Company write us, under date of July this year, "We have pleasure to report the success of the cable supplied by you to our company since the early part of 1884. Although we have several miles of your cable through iron pipes, corroded by the action of the sea and rain water, we have never had a fault, and there is no noticeable depreciation in the insulation resistance of 600 megohms per mile. The cables have been used for high tension currents connected to Brush machines at pressures from 1,500 to 2,000 volts."

At West Brompton, the Fowler-Waring cables on trial there have been abandoned, and our vulcanised rubber cables are exclusively used. With regard to the further statement that Mr. Ferranti has found that the Fowler-Waring cables are the only ones that will stand 10,000 volts pressure, a similar statement was made in a French paper, and we wrote to Mr. Ferranti, who replied to us as follows:—

"He certainly did not get the information from me that your cable broke down when tested with 10,000 volts. Certainly a number of cables did break down under varying pressures, and no cable was found which was sufficiently good electrically, and within the bounds of possibility commercially. Still, he should have mentioned that I applied to the Silvertown manufacturers, and did not receive which I wanted from them. I very much regret the trouble this has given you."

We believe the Fowler-Waring cables have been condemned the reason Mr. Ferranti did not order the 10,000-volts cable from us is that he did not consider that they were within the bounds of possibility, commercially.

In this we cannot agree with him until he produces, at a lower price, a cable that will work as successfully at this pressure as our own would.

As you are the City Electrical Engineer for Liverpool, we think we should put the above before you, and we beg to ask (as you appear to think highly of the Fowler-Waring cable), what is your experience with "Callender" cables?

Awaiting the favour of your reply,

We are, dear Sir,

Yours faithfully,

(Signed)

R. T. CURRIE.  
For the Company.

THE TELEGRAPHIC JOURNAL AND  
ELECTRICAL REVIEW.

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CYCLES.

THERE are those who maintain that what happens to-day has happened before and will happen again, and that the periodic recurrence of an event may be defined with an accuracy almost approaching to the determinations of the exact sciences. All that is necessary is to ascertain the duration of its cycle. In the branch of natural phenomena we are told of the number of years which may be expected to elapse before one great storm will be followed by another. Experts in their respective branches prognosticate without any reserve the date of the next great financial crisis, or the re-appearance of African lions in London drawing-rooms. To scientific cycle-ists (we adopt this spelling to distinguish them from the bi-, tri-, and electric- varieties) the progress of the Salvation Army in this decade, and the propagation of General Booth's scheme in the present year, are easily explainable by the law of recurring intervals applied to religion and philanthropy. Such a law in politics is generally recognised, though careful exponents of the science who are at all jealous of their prophetic reputation, are generally a little vague in their assertions in this department. Political events, like comets, sometimes become wrecked among satellites, their progress retarded, and their cycles disturbed. In the department of History there are two sub-sections—(A) dealing with cases in which history repeats itself, and (B) with cases in which it is repeated by others. In sub-section (B) is included the science of the cycles governing the rediscovery or revival of practical inventions and their supposed anticipation.

We have been partially converted to the views of the cycle-ists. When conversion once begins, there is no knowing where it will end; but, at present, we only pin our faith to the application of the science in the department of History, sub-section (B). By careful study we have acquired such proficiency that we have no hesitation in commencing our public exposition of the science by predicting the revival of the Bourseul

telephone project in from eight to ten years' time. We do not put this suggestion forward on mere guesswork but on scientific principles. We have discovered the circumference of its cycle.

When Mr. Latimer Clark kindly sent us the Bourseul article the other day we did not insert it, but remarked that all the information on the subject was well known. Yet it has gone the rounds of the electrical press with all the interest attaching to new material. Our contemporaries, wiser than ourselves, did not overlook the incidence of the law of recurring intervals, and the result of it is we are weeks behind, instead of being, as we fondly imagined, years ahead.

Regarding the matter from this point of view, we are bound to confess that the period which has now received scientific sanction, is a reasonable one. In intervals of ten years *Punch* might republish its obscure jokes and the *Daily Telegraph* its social leaders, except for the uncomfortable people whose mission in life it is to discover such coincidences and write to the editors of rival prints to announce their discovery. In earlier centuries the interval would have been longer, but now the storm is fiercer and the stress is greater; so much new material has to be assimilated, that it is excusable to forget the old. And, when the revival comes, there are many to whom the information is new, so that what with those who never knew, and those who knew and had forgotten that they did know, the interest in the subject is wide and general.

We now see that our apologies are due to Mr. Latimer Clark for not recognising that he was the instrument of the mystic power which controls the cycles, as well as to our readers for withholding information of a novel and interesting character. We make haste to amend. Our readers will please consider it has been recently discovered that back in the fifties "a certain M. Ch. Bourseul" conceived the idea of transmitting speech by means of a vibrating disc set in motion by the voice, and, coincident with its vibrations, making and breaking an electric circuit. A similar disc at the

receiving end was to undergo in the same time the same vibration, and speech be reproduced. Bourseul's idea was of telegraphic derivation, and its similarity in outline to the telephone has led to the suggestion that it need only have been submitted to practical experiment to have given us the telephone in '54 instead of '76. We thought it was known long ago, but our readers will please to again consider it has only recently been discovered, that speech would be impossible by the method suggested. The reason why we give below, in an extract from an exposition of the telephone for the general reader. We select this description, because it helps us out with our cycle theory by having permitted itself to be published in 1882. After remarking that in 1854 Count du Moncel referred to Bourseul's suggestion as a "fantastic idea," and in 1879 the same Count du Moncel published an account of the telephone which carried out the fantastic idea, the author says:—It will be observed, however, that the apparatus which he suggested would not be capable of transmitting speech. A vibrating disc, making and breaking an electric current, would enable a simple sound of a certain number of vibrations to be reproduced, but would not be sufficient for the transmission of speech. M. Bourseul did not overlook the complex nature of the sounds of the human voice, but in his paper referred to, failed to suggest any practical means for their electric transmission. Professor Bell claims to have been the first to utilise the "undulatory current" which made the transmission of speech possible. A disc connected with a battery and vibrating against a wire would enable an electric current of definite strength to be sent through the wire a certain number of times in a given period; but the speaking telephone admits of the sending through the wire a current that is not always of the same strength, but whose intensity varies or "undulates," and so is capable of far greater variety than the mere make and break.

## THE ELECTRIC CONSTRUCTION CORPORATION, LIMITED.

THE vulgar refrain, "It's wonderful how they do it, but they do," has been ringing in our heads ever since we read the report and balance-sheet of one of the large electrical companies the other day. But light has broken upon our benighted minds, for the *Oracle* (see another page) has spoken. Oracles are usually ambiguous—not so the daily of that name in its article of the 8th inst. It points out that the very important item of £128,117 in the balance-sheet of the Electric Construction Corporation represents shares in subsidiary companies at par, shares included in the original purchase at nominal value, and debts due by subsidiary companies. It then proceeds to dissect the subsidiary companies, and throws doubt on the par value of their shares. The companies mentioned are the Foreign and Colonial

Electrical Power Storage Company and the Electrical Construction and Maintenance Company. As the profit and loss account of the E.C.C. is based on this valuation, it suggests that the directors have not been discreet in reckoning the profit at the figure they have done.

The same idea has occurred to others. As the *Oracle* says, the directors are very able men, and we will add the suggestion that had they been able to convert the mass of paper they hold into sterling, they would doubtless have done so. If the value of a thing is what it will fetch, and these shares have not fetched par, it is reasonable to conclude that they are not worth it. No allusion is made in the article under review to the Electric Traction Syndicate, who paid heavily for promotion, and the right to use E.P.S. cells; and so we suppose we must not class the undertaking as a subsidiary company. Perhaps it is better than a subsidiary company, as it is reported to have disgorged cash, and not paper. So much the better for the Construction Corporation, and worse for the Traction Company. There is one other item to which our contemporary does not call attention—the cash balance. Perhaps they thought it was borrowed for the occasion, or hired, to speak more correctly—a kind of dress-coat in which to appear at the general meeting.

We have known men who never had a cash balance, unless they had raised it on loan, and whose only assets consisted of pawn-tickets. But companies are obliged to have their accounts audited, which is a good thing—especially for the auditors.

Some years ago, at a meeting of the old E.P.S. Company, when the younger brother of this balance-sheet was presented, and a paper profit shown, a shareholder, on asking why the profit would not be divided, was met by the chairman, who, with his usual directness, naïvely replied, "Because we haven't got it." They have it now—somehow, and are going to divide it.

We note that the Construction Corporation has taken up the Ward Omnibus business, and rumour credits it with a third of the City lighting, so it will soon have its hands full, and we sincerely hope its large works at Bushbury, not forgetting Millwall, too, likewise its coffers, for they will have to bear a strain under which paper might give way. We hope they will prosper in the good time coming—the electrical sweet by-and-bye.

Premature  
Announcements.

NOTHING depreciates the value of an invention, or application thereof, or lessens the confidence of the public, more than premature announcements of what is intended to be done. Yet for months and months has a contemporary stated that "in a few weeks" electric omnibuses will be plying on London streets, whilst a short time ago a representative of our contemporary stated that he saw one of the "new 'buses" carrying passengers. That statement was not only erroneous but the chairman of the Ward Electrical Car Company, at the meeting last week, actually said that the details of the contract for the first line of omnibuses had only just been settled.

Electric Lighting  
Difficulties.

EVERYBODY will sympathise with M. S. Z. de Ferranti in his trouble caused by the fire at the Grosvenor Station, even though they may not believe in his system. The complaints regarding the interruption in the supply of light have been so numerous that some customers have regretted having become clients of the London Electric Supply Corporation. The serious and second interruption last week might have been avoided had the "Festina lente" policy been pursued, instead of hastily repairing partially-destroyed converters, and putting up new transformers in a temporary manner.

Accumulator  
Traction.

IF the announcement be true that the E.P.S. cells can be maintained at a cost of one penny per car mile for 50 cars for traction purposes, storage battery traction should receive a great impetus in this country. The accumulator cars on the Barking line would probably have been remunerative to the General Electric Power and Traction Company had the depreciation been covered by one penny per car mile, and if the cars had been operated in a district where plenty of passengers is the rule and not the exception.

A Broker's View.

THE gradually increasing interest shown in the application of electricity to tramway traction is exemplified in the December report of Mr. W. W. Duncan, who is a well-known authority on tramway matters. Says Mr. Duncan:—"There is always the very important offchance—I look upon it as a certainty before long—of electricity as a motive power largely reducing the working expenses. It is already doing this in a very marked degree in America, where it is adopted in nearly all the towns and cities which I visited; but the system most in use is that of overhead wires, which is entirely unsuited to our country. I applaud the administration of our tramways for being in no hurry, and carefully avoiding anything experimental, but once they are satisfied, and I think the time is coming near when they will be, there will be a complete revolution in tramway affairs, and I trust my clients and I will be in at the feast of fat things."

Electric Traction  
Data.

WE shall publish in a future issue a paper recently read at the Chicago Electric Club by Mr. T. P. Bailey. Mr. Bailey furnishes data of operating expenses for one particular road carrying 20 electric cars. These are stated to be a little over six cents or three pence per car mile, and doubtless include repairs and depreciation. The author refers to the fact that there are still some complaints of excessive cost for repairs and maintenance of the electrical apparatus, but he insists that the responsibility for this condition does not altogether rest with the manufacturers. The managers of electric roads are exacting a greater mileage duty than is expected of the ordinary railroad steam engine and under conditions much more unfavourable. If they would see that their tracks are in good order, and the same care and attention given to the electric motor that is given to the steam engine, they will have little to complain of. "How rarely," exclaims the author, "do you find an electric motor operated on a track like that prepared for the steam engine? And how seldom do

you find a man in charge of the motor who has the intelligence, training and experience of the steam engineer?" We are fully in accord with Mr. Bailey, and we do not hesitate in predicting that the future success of electric railways will be due as much to skilful manipulation as to good design. Mr. Reckenzaun, in his paper on "Electric Traction Data," has shown that the same driver could, after he had acquired the necessary experience, under precisely similar conditions save 25 per cent. of the energy, and it was suggested at the time that comparative power tests should be made with the purpose of ascertaining the skill of the operator. Accidents to motors, switches and gearing will be reduced in a similar ratio by ordinary care and experience combined with that intelligence which the position of a driver demands, but without which no man should be allowed to assume the responsibility.

A Disclaimer

IT is with much pleasure that we insert the letter of Mr. A. W. Stokes on the subject of his report on Count Mattei's coloured electricities. Our correspondent holds certificates from Professors E. Frankland, J. Percy, F. Guthrie and several others, and his own letter will show how a report, which may have been scientifically accurate, can be garbled in the hands of interested or ignorant parties. Probably Mr. Stokes does not know how long and earnestly we have striven in all directions to put down electropathic quackery, but thanks to the aid it receives from the daily press it still flourishes.

British Insulated  
Wire Co.'s Cable.

WE have received a report by Mr. Charles H. Yeaman, electrical engineer to the Liverpool Corporation, with reference to tests of samples of this cable. The report is decidedly full, but we miss several very important details. We are told, for instance, the manufacturer's number of the galvanometer and other instruments used in making the test, but nothing is said about the quality of oil used in the galvanometer lamp, nor are we informed by whom the terminal connecting screws were supplied, nor whether the emery paper used for cleaning the wire connections was supplied by Messrs. Oakley—its degree of coarseness is not even given. But, seriously, we have seldom, if ever, read a report of a more absurdly bombastic much-ado-about-nothing character, and though we have no reason to doubt the correctness of the tests, the whole of the letter might have been given in a few lines. Of the value of the tests it is difficult to judge from the insufficiency of information. It is not stated, for example, whether all the cables were lead-covered; if they were, the statement that the insulation of a certain cable kept in the rain for 10 days was good owing to the "impregnation during manufacture with a heavy oil" is absurd, it is simply due to the soundness of the lead-covering, a soundness which is nothing remarkable. The only test made of the moisture resisting properties of the insulated material appears to be that of a piece of electric light cable *two yards* long with the lead stripped off soaked in water for 24 hours, a test which, of itself, is insufficient to be conclusive. We do not say that the cable is not good, but as yet, we have heard of nothing which indicates that it is better than that of other manufacturers.

**ELECTRIC LIGHTING AND TRANSMISSION  
OF POWER IN ITALY.**

AN important installation for the transmission of electrical energy for lighting and motive power purposes is now being carried out by the Italian Edison Company, near Intra, in Italy, for Mr. Carlo Sutermeister. This gentleman has a concession of 840 effective H.P. situated near the latter town, which is about six miles distant from Pallanza. The fall of water is 135 feet, and the quantity about 440 gallons per minute. It is obtained from a canal which is fed from the S. Bernardino river, near Cassagno, and runs for some distance in tunnels. The installation, when completed, will comprise four Girard turbines, each of 150 H.P., and each being coupled direct to a dynamo having an output of 96,000 watts (32 ampères at 3,000 volts), and an exciter of 4,000 watts capacity (40 ampères at 100 volts), and one Jonval turbine of 150 H.P., which also actuates an alternator and exciter of the same capacity. The turbines are fitted with an automatic regulator recently designed by Messrs. Ganz & Co. The plant will be used for supplying light and power to Intra, Pallanza, and neighbouring districts. The considerable distance between the generating and distributing stations rendered it necessary to use the same conductor for transmitting energy for both lighting and power purposes. The Edison Company therefore adopted the alternators, turbines and motors made by Messrs. Ganz & Co., of Buda Pesth, whilst the remaining electrical apparatus—transformers, lamps, meters, &c., are being supplied by the former company. The conductor, which is of bare copper wire, is being carried overhead on oil insulators, attached to standards, and the loss in transmission from one station to the other is estimated at 10 per cent. The efficiency of the turbines is guaranteed to be 75 per cent., of the alternators 88 per cent., and the transformers from 90 to 95 per cent. The motors will range from 3 to 50 H.P. Those from 3 to 20 H.P. will be energised from separate transformers, whilst the larger motors will receive current from the primary conductor at 3,000 volts, these motors being arranged in series. The current will be measured by Blathy wattmeters, and the installation is to be in full operation in March next.

**THE ELECTRIC LIGHT IN PARIS AND THE  
SMOKE DIFFICULTY.**

THE Council of Hygiene and Salubrity of the Seine last week appointed a committee composed of MM. Léon Colin (President of the Army Health Council), A. Gauthier (Professor of Chemistry to the Faculty of Medicine), Léon Faucher (Chief Powder and Saltpetre Engineer), Linder (Inspector-General of Mines), and Michel Lévy (Chief Engineer of Mines), to study the dangers of smoke from a hygienic point of view, and to prepare a scheme of regulation. It may be remembered that in June last the Council expressed the opinion, but in vain, that the electricity stations and motor force works, which produced a deal of smoke, should be placed among establishments which were regarded as dangerous, unhealthy, or inconvenient.

What with the smoke difficulty and the obstruction caused to the traffic by the laying down of the canalisation, the electric light is receiving quite its fair share of attention in Paris. It is also being discussed now from another point of view, one of our contemporaries printing the following article under the heading of "Precautions to Take":—

A beginning has hardly been made to instal the electric light in Paris, and already it begins to show itself as a cause of accidents. This is nothing surprising, and is not of sufficient gravity for one to deduce therefrom the condemnation of this kind of lighting. Side by side with its particular inconveniences it presents great advantages, which are

quite special to it. But in the facts which were set forth at the Municipal Council recently in connection with the fire and explosion caused by electricity in a café on the boulevards, an accident which was the twenty-first which had happened at the same place, one conclusion was seen very clearly—an effective surveillance of the electrical posts and installations. At the present moment, small electrical installations made inside a house, when the electro-motor power does not exceed 60 volts for alternating currents and 500 for continuous currents, escape every kind of surveillance. One is not even obliged, before establishing them, to previously officially notify the competent authority or the prefecture of police.

This is an instance for obtaining an alteration in the present state of things; but as time will be necessary, and that maybe the instance will not come to anything, there is certainly something else to do. Why should not the authorities of the City of Paris introduce into the agreements for concessions of electric lighting conditions of a nature to protect public safety? Why should they not require, for instance, the concessionaries to agree to an efficacious inspection of *all* their installations by a competent administrative service? Why not compel them also to establish their works and stations under such conditions that neither smoke, vibrations, nor other inconveniences of which complaint has been made should arise in the future? The electrical concessions are a bargain, an agreement between the authorities of the city and the concessionary; no one, therefore, could object to the former requiring from the latter, in exchange for advantages conceded, certain dispositions which are now recognised as necessary for the public safety and health. This is the more necessary, as the agreement between the city authorities and the Gas Company will grant the latter—if it be definitely settled—the right of working the electric lighting, and the working of the Gas Company will very probably be by means of small installations of the nature of those which at present escape all species of control. It is not therefore useless, in our opinion, on this particular point to call not only public attention, but also that of the Third Committee of the Municipal Council and that of the Council itself, to the subject. The precaution which we indicate would quite naturally find its place in the agreement which the Third Committee of the Municipal Council has under consideration at the present moment.

**THE ARTIFICIAL LIGHT OF THE  
FUTURE.\***

By PROF. EDWARD L. NICHOLS.

AS we review the history of the electric light, we find that in two respects there is little cause for congratulation. When we come to consider the quality of the light produced and the efficiency of the apparatus as a light-making machine, we find that the incandescent lamp of to-day produces the same quality of light which the earliest examples of its type were capable of giving. It is true that the efficiency of the incandescent lamp has gradually risen from 5 to 3 watts per candle, but those who have had occasion to trace the discouraging life curves of such lamps know how little real progress the change implies. We start a well manufactured lamp at any temperature we please, provided that we do not pass a certain limit, beyond which the life of the lamp would be too seriously curtailed. The initial efficiency may be made as large as we please, within that limit; but it is only a question of a few days or hours when the lamp will have dropped to the dead level of mediocrity, the 5-watt level which seems to mark the confines of permanency in the case of incandescent carbon.

\* Abstract of paper read before the New York Electric Club, November 20th, 1890.

In some experiments made by me, in the first instance a lamp was started at the candle-power indicated by the maker, and was held at constant voltage by means of the current from a storage battery. The initial candle-power was 16, which was obtained at the expenditure of 3.015 watts per candle. Measurements of electromotive force and current were made at intervals of about 10 hours, during the 800 hours that the lamp lasted. The candle-power was redetermined at intervals of about 100 hours. The voltage never rose more than 0.65 volt above its initial value, and then only for a short time. The average electromotive force of the entire run was 0.40 volt below the initial value. The characteristic features were rapid, followed by slower falling off in candle-power, the decrement amounting finally to more than 50 per cent., and rapid, followed by slower, falling of efficiency, to a final value of 5.75 watts per candle. These changes were accompanied by continuous and marked increase in the resistance of the filament.

If it be asked whether this individual case represents a state of affairs common to all incandescent lamps, I can only say that in my experience, which is certainly much less extensive than that of some others, I have known of no class of lamps the performance of which did not agree approximately with the latter results. Mr. W. H. Pierce,<sup>†</sup> who described extended tests of the initial and average efficiency of incandescent lamps in a paper read before the Institution of Electrical Engineers some time ago, recorded no exceptions to this rule of decreasing candle-power and efficiency with time.

This falling off in candle-power exhibited by lamps maintained at constant voltage can be met by a procedure not easily applicable, perhaps, in commercial work, but readily carried out where the object in view is simply to study the behaviour of the lamp under unusual conditions. The method consists in raising the electromotive force at short intervals of time by amounts sufficient to restore the candle-power to its normal value.

The results of such an experiment performed upon a lamp showed that under this treatment the life of the same was not quite 100 hours. The total rise in electromotive force during the test amounted to about 9 volts; the efficiency decreased from 3.118 watts per candle to 3.468 watts per candle. The resistance of the filament rose from 221.6 to 234.8 ohms. During the first 50 hours the changes were slight, then occurred a sudden increase of resistance, accompanied by marked rise in electromotive force and in amount of energy consumed.

The life history of the incandescent lamp at still higher temperatures does not differ essentially from that which we have just been considering, but the changes in question go on much more rapidly.

In another experiment, a lamp was started at 57 candles. It was maintained at constant voltage for 11 hours and 30 minutes, when it went out. During its brief life the candle-power fell to 24.6c., and the watts per candle increased from 1.58 to 3.09. The loss of candle-power during the experiment was 55 per cent., an amount which corresponds very closely with the loss suffered by the first lamp tested during the 800 hours that it lasted. In the case of another lamp, the initial candle-power (64 candles) was maintained throughout. Its life under these circumstances was 140 minutes, during which short period it had been found necessary to raise the electromotive force from 114.08 volts to 129.53 volts. The efficiency of the lamp fell, meantime, from an initial value of 1.33 watts to 1.677 watts at the end of the first hour; then more and more rapidly to 1.945 watts at the end of the test.

The conclusion to be reached from these data, and from the great mass of experimental results which has accumulated since the incandescent lamp has become an object of investigation, is only too evident. The efficiency of an illuminant in which carbon is the glow-

ing material is a function of the temperature. It appears that the incandescent lamp is fairly stable only at temperatures for which its efficiency does not exceed about five watts per candle. We have just seen what occurs when one attempts to maintain lamps at degrees of incandescence corresponding to a much higher temperature. It is, perhaps, not possible to point out with perfect definiteness all the causes that are at work to reduce the candle-power. The black coating which gradually forms on the interior of the lamp-bulb intercepts more and more of the light from the filament as the age of the lamp increases.

With regard to the absorbing power of this film, it was found that this was very nearly uniform throughout the spectrum, so that the blackening of the lamp had no appreciable effect upon the light which it emitted; also that the absorption at the end of 200 hours was considerably more than half as great as that at the end of 800 hours, and that the total loss of candle-power due to blackening was about 22 per cent.

These measurements enable us to account for rather more than one-third of the loss of candle-power suffered by the lamp. We are not, with our present knowledge, in a position to speak so definitely concerning the other two-thirds, but the increase in the resistance in the carbon indicates another source of diminution. That gradual failure of the vacuum which the use of the spark coil would unquestionably have enabled the observers to detect, may well be answerable for the rest. Now, the temperature of an incandescent lamp filament at 5 watts per candle is very nearly the same as that of the carbon in the light-giving flames produced by the combustion of oils and gas, and it appears that the attempt to pass this temperature introduces difficulties of such a nature as to lead to the serious question whether we have not reached a definite limit, beyond which incandescent carbon ceases to be permanent.

At that limit the efficiency of the lamp is very small indeed, 95 per cent. or more of the radiant energy emitted being of wave lengths too long to afford light.

As to the arc light, no more encouraging report can be made. On the contrary, it is perfectly well established that the quality of the light, instead of increasing, has fallen off, in the course of the development of the lamp from the clock-work regulators of Dubosc and Foucault, with their slender carbons, to the commercial lamps of to-day.

In the vast accumulation of experience which the past years have witnessed, nothing has come to general knowledge which looks to the raising of the barrier which blocks our progress. It seems only too probable that the limiting temperature at which carbon can be used for the production of light has been reached, and with it the maximum efficiency of artificial illumination.

What is to be the light of the future? From the standpoint of the engineer, I will frankly say that I cannot answer that question; but abandoning the directly practical point of view, there is something to be said. I need offer no apology here for presenting facts, the application of which is at best remote, and the present importance of which is therefore rather scientific than utilitarian; nor need I remind you that all the so-called "forces of nature" which have been yoked and impressed into the service of man, were the object of scientific curiosity, and the subject of scientific investigation long before the idea of a practical application was entertained.

The number of elements and of compounds capable of sustaining a high temperature without dissociation or change of state is very large. Carbon is the only one of these, the capabilities of which, as a source of light, can be said to have been fully tested; and yet all the others, when heated to a proper point, emit light-giving radiation. Take for example the metallic oxides. We heat the oxide of calcium in our magic lanterns, and it gives us a light of great intensity, and but little inferior to the arc light in whiteness. The exceeding clumsiness of our method of rendering it incandescent, however, has prevented its adoption, excepting for cer-

<sup>†</sup> W. H. Pierce: *Transactions of the American Institute of Electrical Engineers*, vol. vi., p. 293.

tain special purposes. We burn magnesium in fire-works and for photographic flash lights, and occasionally we indulge in the luxury of igniting a bit of the ribbon, and admiring, for an instant, the intense brilliancy of its flame. Now, magnesium is one of the most abundant elements on the face of our planet. It is a rather costly metal at present, being quoted at 50 cents an ounce in this country, and at about half that price on the continent of Europe. Even under the limited demand for it which exists at present, it has fallen to about one-tenth of its price of a few years ago, and I feel sure that it lies within the power of the electrician to greatly further reduce the cost of production. Among artificial illuminants, magnesium has in one respect no equal. W. H. Pickering, who studied its spectrum in 1880, found it to approach sunlight in quality even more closely than the electric arc light does.

Weight for weight, magnesium affords more than 30 times the light obtained from gas, with the development of much less heat. The quality of the light is such that merely from the standpoint of illuminating power, to say nothing of the additional æsthetic value of a light which approaches sunlight in whiteness, each unit of it must be regarded as the equivalent of rather more than 1.25 units of light.

The study of the radiation of the metallic oxides above the red heat reveals the existence of properties which lead us to regard them as being luminescent "by heat." It is from such bodies that radiation of high efficiency is to be looked for. We have in magnesium oxide a member of this particular class, and when it is heated in the process of formation it gives us a light the efficiency of which is unapproached by that of other artificial illuminants.

The problem is easily stated. (1) We need a body which is rendered vividly luminescent by heat. The metallic oxides would seem to offer us many such. (2) The material is to be brought to the temperature at which its luminescence is most marked. Does it not seem probable that the best method, as in the case of carbon, will not be that of direct combustion, but of heating through the agency of the electric current? (3) The material must be restored from time to time. Whether rejuvenation is to be secured through electrical, chemical, actinic or mechanical means remains to be determined.

Luminescence "by heat" offers, however, only a partial solution of the problem of the highest efficiency. However great the efficiency of the luminescent itself, it is accompanied by incandescence of the ordinary kind. The ultimate solution is to be sought for along other lines. Incandescence is too expensive a means of exciting luminescence. There are many other ways in which it may be generated; friction, chemical action, the impact of light waves, electrical excitation, certain vital processes, are known to result in the production of light. The physics of these phenomena is, for the most part, undeveloped. I know of but two attempts to determine the efficiency of this "light without heat," as it has sometimes been called. The intensity is, as a rule, very small, and the heat has doubtless been regarded as quite below the range of even our most sensitive apparatus. One of these two cases is of especial interest to the electrician. It is that of the spark discharge in vacuo. Prof. S. P. Langley and Mr. F. W. Very, in a recent remarkable paper, entitled, "The Cheapest Form of Light," speak of the heat generated in the Geissler tube as so minute as to seem to defy direct investigation. It has, however, been successfully measured by Dr. Staub, of the University of Zurich, by means of one of the most delicate instruments for the measurement of heat—the Bunsen ice calorimeter.\*

In Staub's experiments the vacuum tube was smoked with lampblack and inserted in the ice calorimeter. The ice melted in a given time afforded a measure of the total heat generated by the electric discharge through the tube. A repetition of the determination with the unsmoked tube, under which conditions the

light-giving rays could escape, gave the energy of the non-luminous radiation. The efficiency was found to be 3.268 per cent. The extremely small candle-power of light derived from the electric discharge in vacuo, may seem to preclude all questions of its utilisation in practical illumination. The result is one, however, which should not be lost sight of. It suggests a field of investigation which may prove unexpectedly fruitful.

The Geissler tube effect was not the source to which Langley and Very applied the term "the cheapest form of light." The subject of their research was the light of a Cuban firefly. Their work cannot fail to excite the highest admiration of everyone who is able to appreciate the difficulties of such an investigation. The exploration of the heat spectrum of so insignificant a source of light is a task which very few physicists would, I think, have considered practicable, but it has been carried through by these investigators with complete success.

When we study the curve of distribution of energy in the spectrum of the fire-fly thus obtained, and compare it with the corresponding curves for gas light, the arc light and sun light, we find the expression, "the cheapest form of light," which is applied to the light of the fire-fly by Langley and Very, to be fully justified. All the energy of its spectrum is massed within the narrow limits of the visible spectrum, and what is more, by far the greatest part of it is in the form of rays which are especially important for the purposes of radiation, the particular rays which give us yellow and green light. The non-luminous radiation which accompanies the light of the fire-fly seems to be so insignificant that it was with difficulty that it could be estimated, even with the almost inconceivably delicate apparatus used by Langley and Very. They give the efficiency as about 400 times as great as that of a gas flame. It cannot fall appreciably below 100 per cent.

I have endeavoured to show that the efficiency of our present methods is too low to meet the demands of the future for economical illumination, and that whether we ever succeed in approaching the perfect economy of nature's light-making processes, as exemplified in the fire-fly, or not, there are many sources of light which promise high efficiency.

## THE ELECTRIC LIGHT AND THE PARIS MUNICIPAL COUNCIL.

[FROM A CORRESPONDENT.]

IN the session of November 24th, to which we referred in our last number, a discussion took place concerning the fire which recently took place at the Grand Café. It was inquired whether the Popp Company was, or was not responsible, and whether it had, in opposition to the regulations, established electric centres in the sunk storey of the Grand Café?

The general secretary of the Prefecture of Police replied, that according to the inquiries made and the declarations received from the proprietors and the manager of the Grand Café, that the Popp Company had installed in an underground hall of the Grand Café, near the gas meter, three batteries of accumulators destined to light up the Grand Café, and partly also to supply a certain number of customers of the Popp Company. The proprietor of the Grand Café had given a written authorisation to the Popp Company to establish a small electric station in their sunk storey, in return for a reduction in the charge for lighting up the establishment; it is alleged that this station supplied about 1,400 lamps outside the café. A continuous current Gramme machine, of 350 volts, sent the current to charge the accumulators. The attention of the council was called to this figure of 350 volts, as of great importance. The engineer of the Popp Company and the manager of the café have declared that safety wires existed in the cables of distribution. As regards the supply cables, the declarations are contradictory. The manager of the café asserts that it is at least the twentieth time that fire occasioned by elec-

\* G. Staub: Inaugural Dissertation, Zurich, 1890. (See the *Beiblätter zu den Annalen der Physik*, 14, page 538.)

tricity has broken out in the café. Two conclusions may be drawn: at present, in most cases, the accidents are produced by the melting of the gutta-percha and the ignition of the wire. A similar accident took place two days later in the Rue de Montmartre and in the place de la Madeleine, the same company having the concession. However, such accidents occur with all the companies. The section of the safety wires is not made proportional to the tensions which it supports and the currents by which it is traversed. It does not fulfil its function. As soon as the current increases in intensity the wire becomes heated, the gutta-percha melts, the wire burns, and a fire breaks out.

The secretary also mentioned as a cause of danger, that small installations in the interior of one and the same property are exempt from the formality of giving notice if the E.M.F. of the generator does not exceed 60 volts for alternating currents, and 500 volts for continuous currents. Such installations like that at the Grand Café can lawfully work in secret. If the company burns down the establishment, no one is authorised to interfere. A modification of the law was therefore urgently demanded, and the universal introduction of safety wires was insisted on.

Another complaint was brought forward on behalf of inhabitants of the Rue Montmartre, who are annoyed by the smoke from an electric station fixed in a neighbouring brewery. Shopkeepers complain that the "blacks" issuing from the enormous chimney damaged their goods. The remedies suggested are the prohibition of coal in boiler furnaces, and the use of coke or of smoke-consuming arrangements.

Many difficulties, however, were pointed out; coke is expensive, and at the electric stations coal of low quality is used from motives of economy. Smoke consumers are not perfectly satisfactory.

The secretary of the Prefecture of Police reminded the council that the visible smoke is not the entire question, as there are injurious gases, such as sulphurous acid, given off in quantity which cannot be got rid of by "smoke consumption" or by the use of coke.

It appears that the electric stations within the city are more especially accused of producing smoke. It was at last resolved, on the motion of M. F. Duval, that there should be distributed to the members of the council, copies of the agreements made with the electric companies and of the agreement giving the Popp Company the right to establish underground channels in Paris.—*L'Electricien*.

## SOME FACTS CONCERNING GUTTA-PERCHA.

(Continued from page 673.)

The study of the gutta-percha trees, from a botanical point of view, the investigation of the conditions surrounding them from a scientific as well as commercial standpoint, may, M. Sérullas says, be divided into two periods. The first embraces private exploration conducted by such well-known names as Lobb, Oxley, Maingay, Teysmann, Binnendijk, Beccari, Van Leer, and Motley. The second, which may be considered to date from 1881, comprises investigations carried out by various Governments in the interests, primarily, of submarine telegraphy. These include researches effected by Seligman-Lui, on behalf of the French Government, in 1881; Wray, for the English Government, in 1883; Burck, for the Dutch Government, in 1883; and Sérullas, for the French Government, from 1884 to 1889.

During this period Morellet, a Frenchman, spent a considerable time in Malaysia studying the subject, but on a personal and commercial account; and in 1885-1886 Father Scortichini investigated the various species found in the Malay Peninsula. The notes attached to his herbarium, now at Calcutta, were intended to have

been incorporated with a history of the flora of the English Straits Settlements.

Commencing with the earlier history of the gutta-percha industry, that is to say, the first period above referred to, there appears to have been a considerable trade previous to 1842 in the hands of Chinese merchants at Singapore; and although in that year Montgomerie made the existence of the gum known to the civilised world, and specimens were brought to Europe in 1843 by Joré de Almeida, yet it was not until 1847 that Thomas Lobb discovered the tree itself, the *Isonandra*, in the interior of the island of Singapore. Ten years after this, the species was considered to have become utterly extirpated in that island, but M. Sérullas discovered a few specimens still surviving in the year 1887.

Between 1847 and 1857, Montgomerie made known that the *isonandra gutta* was to be found plentifully distributed throughout the forests of Sarawak (Borneo), and in the jungle of the Malay Peninsula. He stated that there existed in Malaysia three kinds of gutta, apparently similar as to the tree, but very different in the qualities of the gums, which were distinguished by the natives under the names of *guirek*, *taban*, and *pertcha*.

Oxley went further; he allotted to Borneo alone, seven species of gutta-percha trees. The three best supplied *gutta-taban*, and the best of three was recognised by the yellow colour of the wood.

Confusion now commenced in nomenclature. The native terms were recklessly employed, with the result that the same gum came to European markets under various designations, while absolutely different perchas were labelled with the same name.

To make confusion worse confounded, explorers in search of the *Isonandra* in Malaysian forests, returned with specimens to which purely local names had been given by the natives, the same plant bearing a different title according to the dialect of the locality; and this is not all; it is a fact that during 30 years, these explorers brought back with them not one single specimen of any value. Leaves were indiscriminately collected without regard to the age of the tree, and seldom accompanied by samples of gum obtained at the same time as the leaf.

Later on, as the forests became denuded of the better varieties, the natives made use of species such as *payena*, *bassia*, *sideroxylon*, *chrysophyllum*, and *mimusops*. Used at first secretly for adulteration, these varieties of gum were shortly openly employed in mixtures, to which, again, native names have been given, regardless as to their just application. For instance, the Malaysian name of the *payena Leerii* is *gueutta seundek*; but the *guttas-seundek*, as known to commerce, are nothing but complex mixtures.

As the above-mentioned varieties became scarce, the natives entered upon the collection of varieties such as the *soughi-soughi* of Singalang, in Sumatra (the *bassia-pallida* of Burck); the *gourhou* of Selangore, in the Peninsula, and in Borneo (the *bassia motleyana*, of Clark); the *fonou* of Tringalang and Pahang, in the Peninsula (the *ganua chrysocarpa* of Pierre); the *simpor* of Larout and Perak, and the entire south of the Peninsula (the *sidero-carpus Beccarii* of Pierre, or the *dichopsis maingayi* of Clarke).

Lastly, a fresh series of adulterations have recently been entered upon by the employment of the *djeloutong* (*dyera luziflora* of Clarke), from Malacca; the *varingin bringin* or *djerindjing* (*urostigma benjaminum*, of Miquel), from the Malay archipelago; and the *pohon Saoua* (*mimusops Kauki*), from the Celebes.

Travellers and botanists have introduced to the notice of the gutta-percha industry, as possible successors to the *isonandra*, a *chrysophyllum* from Brazil, the *mimusops balata* from Guiana, the *bassia Parkii* from Sénégal, and the *dichopsis Krantzii* from Cambodia and Cochin-China.

The French Government, in view of the rapid disappearance of the better gums, and the almost complete extinction of the *Isonandra*, and considering the critical position in which submarine telegraphy was

placed owing to no substitute for gutta-percha being known, deputed, in 1881, M. Seligman-Lui, an engineer in the telegraph service, to make a thorough and comprehensive examination into the actual conditions and circumstance attending the gutta-percha industry.

To the general confusion in nomenclature thus established, M. Seligman-Lui's report to the French Government, which we reviewed in our issue of April 12th, 1884, bore ample testimony, and, curiously enough, M. Seligman-Lui, as we then pointed out, had himself fallen into several errors in the classification of various species, due, no doubt, to the same causes which had led other investigators astray.

With the mission of M. Seligman-Lui the second period may be considered to have commenced. But, continues M. Sérullas, this expedition could not, in the circumstances, succeed in obtaining any definite or conclusive result. How, he asks, could an investigation extending over a few weeks only decide questions which so many explorers, during more than 30 years, had been unable to elucidate.

The voyage, therefore, resolved itself into a search conducted in the forests of Assahan, Sumatra, for some kind of tree which would supply a gum suitable for telegraphic purposes, and any subsequent expedition, instead of undertaking the quest of an *Isonandra* of a particular species, would merely have to apply itself to an examination of a given gum under a local name, and in a forest indicated.

One of the principal objects of M. Seligman-Lui's mission was to discover a tree giving the desired gum, which might be successfully cultivated in French territory. In the forest of Singalangan, on the river Ayer-Siloh, at the extreme limits of the Assahan district, M. Seligman-Lui noticed six kinds of trees called *mayang*, which were easily distinguished from one another. Among these one variety was found, the *mayang taban derrian*, which supplied a gum of the best quality, and which might, without any hesitation, be cultivated, in Cochin-China. Another variety, called the *gutta-batou*, gave a second-class gum, while the rest, known to the natives as *belouk djerindjing*, *korsik*, and *kalihara*, or *kartas*, produced a sap of no value. Young plants of the required species were collected and sent to the French colony at Saigon; and at Siak and Pakan Barhon plants of the *gutta seundek*, and *gutta taban* were obtained and forwarded to the same place.

The authorities in charge of the botanical gardens at Saigon unfortunately lost all these plants, and the Government of the British Straits Settlements was applied to for assistance in the matter. So urgent were the demands, that the Straits Government, convinced of the importance of the subject, deputed Mr. Wray to thoroughly investigate the gutta-percha industry in the State of Perak.

Mr. Wray was especially well qualified to undertake such a mission. Botanist and chemist, he spoke the Malay language perfectly, and in comparing the results of his expedition with those attending M. Seligman's voyage, it is only fair to the latter to mention that in addition to the advantages above indicated, Mr. Wray possessed superior facilities in the matter of time, transport, and finance, as well as exercising absolute control and authority over the natives.

Specimens of nearly every variety of gum-producing tree growing in Perak were collected by Mr. Wray. These specimens consisted of branches, flowers, fruit, wood, bark, and gum, and sufficient samples were obtained to supply the museums of Kew, Calcutta, and Taiping (of which Mr. Wray was director) with complete collections; a further set of specimens was given to Madame Errington Delacroix, who subsequently presented the collection to the Paris Museum of Natural History.

Although Mr. Wray's report was published in December, 1883, little or nothing is known of this, in every sense remarkable, expedition, either in France or Java. M. Brau de Saint-Pol Lias is credited with the discovery of the *gueutta taban mérah*, and M. Erring-

ton Delacroix is spoken of having brought to light the *gueutta taban soutra*.

Yet both these trees, which supply most excellent gutta, were discovered by Mr. Wray; the first mentioned at Oulou Plouss, the second at Oulou Kénéring.

Besides these two varieties, the following trees, whose gums are exclusively used for the purpose of falsification and adulteration, were found by Mr. Wray:—

*Gueutta Seundek* (or *Payena Leerii*; from Sapetang and the Buto River. There are two varieties in the province of Larout.

*Taban Pouteh*; from the forest of Larout, Kouala Kangsan, Hipoh. Also found in Lahat, Djouang, Tapa, Oulou Pahang, &c.

*Taban Tchaier*; from the falls of Larout, Perak, Pahang, and Patani. There are several varieties of this species.

*Simpur*; from Oulou Kénéring, Oulou Ploss, Slem, &c.

*Simpur*; another variety from the falls of Larout.

*Djeloutong*; from Larout.

*Gourbou*; from Larout.

The action taken by the Government of the English settlements in the Straits, as a result of Mr. Wray's expedition, was to forbid the cutting of any gutta-percha trees throughout British possessions. This interdiction came, however, too late, as, not long after Mr. Wray's mission, many of the forests explored by him had been entirely denuded of gutta-percha trees.

When M. Sérullas visited Malaysia he had the advantage of being accompanied on one of his trips into the forests by Mr. Wray, who appears to have placed his notes and reports at the disposal of the author of the present article.

(To be continued.)

## MR. GLADSTONE AND THE TELEGRAPH SERVICE.

THE Right Honourable William Ewart Gladstone has, during his eventful and phenomenal career, been compared favourably and unfavourably to classic mortals and immortals of all types and shades, from "the wily and familiar conjuror," and the indefatigable hairsplitter of everything argumentative, to the simple "Grand Old Man," and the modern embodiment of much anciently held sacred by Greece and Rome. Hero worship, indeed, has caused him to be looked upon by many as the Alpha and Omega of nineteenth century progress, and no praise has been deemed too extravagant wherewith to belaud the vigorous and hearty octogenarian statesman. Those who have not indulged in such perfervid pæans, but have gone to the other extreme, and heaped abuse and unstinted obloquy on the name and fame of the "people's William," stand very much in the position of the negative to the positive current—the zinc to the copper, technically speaking—and the one seems to be, in a sense, indispensable to the other.

It is not our intention to indulge in a political disquisition in these matters, but it may be interesting to our readers to know that in the telegraph service generally, Mr. Gladstone is regarded as a sort of political and telegraphic Hannibal, one whose movements and speeches are regarded by telegraphic clerks with peculiar interest, not to say anxiety, for there never has been a statesman, nor indeed any public man, whose utterances have been so assiduously snapped up by journalists, and incontinently hurled, through the medium of the telegraph service and the press, at the heads and hearts of an always inquisitive reading public.

Into the political aspect of the position of the parliamentary Hannibal we need scarcely enter at great length.

The mighty Carthaginian, the terror of Rome, after crossing the bleak and tempest-scourged Alps, and descending into the fertile valleys of the Po in making his final arrangements for the wonderful campaigns which enabled him to maintain himself in aggressive

hostility to Rome for fifteen years, destroyed the whole of his transport and supplies—a bold and daring step—but fortune favoured him, and his victorious troops found supplies and spoil in plenty in the camps of their routed adversaries.

The modern political Hannibal, it is said, has abandoned his line of communication and his allies, and even now looks with contempt upon those who, in the past, helped him to build up the fame which will make his name a landmark in English history.

The allies of the modern political Hannibal, however well meaning his intentions may be, are not to be mentioned in the same breath with those faithful warriors who followed the amiable and generous-hearted son of Hamilcar through his many vicissitudes in Italy. Unlike the Carthaginian's experience, victory has not at the outset declared itself for the Old Parliamentary Hand, and there is apparently very little or no prospect of it in the near future for those who follow his fortunes.

Returning now to the telegraphic Hannibal, it may be said that were the extra labour and skill called into play in the telegraph service on the occasion of a Gladstone "night" unrewarded, in a pecuniary sense, the alarm and consternation with which the news of the advent of Hannibal into Italy was received in Rome would find a strong professional chord in the heart of the apprehensive telegraph clerk. The first and greatest Midlothian campaign—that of 1880—produced great receptions, great orations, and great political results. An army, so to speak, of reporters plunged into the sea of words, sentences and periods were seized as they flowed in exuberant profusion from the unwearying lips of the great and popular favourite of the million. From the journalist to the telegraph clerk is but a family transfer. In Edinboro', a small army of telegraph clerks, or, as they are now termed, telegraphists, was engaged unremittingly in preparing and sweeping over the wires, north, south, east, and west, the sympathetic sentences of the Old Man militant. Thousands upon thousands of words were dealt with expeditiously and methodically each evening, providing close and monotonous work for hundreds upon hundreds of men throughout the whole English telegraph system. Abundant in rhetorical resource, as the Hannibal of old was inexhaustible in military intuitiveness, Mr. Gladstone is equally at home on the divine blessings of peace, the glories of national freedom, Home Rule, Crown Derby, Homer, large potatoes, the use of jam, or the study of Moses, it follows that the telegraph clerk plays no mean part in the presentation of his utterances to the public. After the Midlothian campaign came the introduction of the Home Rule Bill by Mr. Gladstone in 1886. The scene in the Central Telegraph Department was one never to be forgotten. The day was dull and dark, auguring no good for the gigantic task which the veteran Prime Minister had undertaken in the House of Commons. He began at about half-past four o'clock, and spoke for nearly three hours.

From 4 o'clock in the afternoon until 3 the next morning, upwards of 400 men were engaged in dealing with the transmission of press work incidental to the propounding of this short-lived scheme alone. Extraordinary preparations of circuits, extension and making up of wires, insertions of relays, repeaters, testing of batteries, &c., had been engaging the attention of the officials for some days previously. The heads of departments honoured the scene with a visit, and they must have been surprised to find that the noise alone made the work seem like that of a factory. The number of words telegraphed aggregated fully one and a-half millions. The spirit of the moment was fully entered into by the staff, and the scene was animated beyond all description. Men were seen hurrying here and there with work for the hundreds of operators to whom the task of preparing slips for the Wheatstone automatic had been allotted. Others were to be seen deciphering the wretched "copy," which is generally the source of numerous errors, and also of loss of time. Everything is done on these occasions of extraordinary pressure in a methodical and systematic manner, every

man falls into his place, and knows what is required of him to help the general exodus of business.

Through all these times of important pressure, the sheet anchor of the service, and the only one by which monster speeches can be satisfactorily dealt with, is Sir Charles Wheatstone's automatic system of telegraphy, improved very much certainly since its introduction by the inventor upwards of 20 years ago, but still in principle very much the same beautiful, reliable, and perfect medium of communication.

It is a common practice in the General Post Office for the Postmaster-General to express his thanks to the staff for their extremely hard and trying labours at Christmastide, Eastertide, and on occasions of great strain on the service. There are, unfortunately, very few instances where similar compliments have been vouchsafed to those performing such trying and harassing work as telegraphy in times of strain and pressure, and such instances not infrequently occur. Every gale or disturbance of the elements leaves its mark on the material of the service, and the hackneyed remark is often passed round that, notwithstanding the general improvements effected in the maintenance of wires, batteries and circuits, Nature now and again reminds us that telegraphy, like some of the other sciences, in a measure is still "at the mercy of the elements." Many a disappointment is experienced by the telegraph clerk when these great speeches or great demonstrations occur; he has on such occasions to give up his science class, his art class, his music, his literature, his friends, and the pursuit of pleasure, and it may be of knowledge also. "Duty" is as serious a matter to him as it is to the sentry on his lonely guard. However, he bears it cheerfully and steadfastly, feeling a genuine interest in his duties, and expecting no higher reward than to hear that all went well on the occasion of the great speech, banquet, or demonstration.

Mr. Gladstone has had greater attention paid to him in the matter of his speeches than any other public man during the past 25 years, but this does not mean that other statesmen and men of fame and position at home and abroad are by any means neglected. It simply shows that Mr. Gladstone in office or out of it, popular or unpopular, is read, and we may add criticised, by the masses of his fellow countrymen to a greater extent than is the case with his colleagues past or present—Liberal or Conservative. The recent Midlothian speeches also entailed much expensive labour to the telegraph service, for it is notorious that press work, owing to the absurdly low rate at which it is charged, is a source of great loss to the Department, and on this point we may have something to say hereafter.

## INDUCTION AND INDUCTION COILS.

By W. MOON.

THE phenomena exhibited by the variation of the number of lines of induction through the core of an ordinary induction coil may be divided into two parts. Firstly, when the discharge is non-oscillatory, and, secondly, when it is oscillatory. It is with the former of these divisions only that I deal with in this paper.

If  $l$ , lines of induction, are threaded through the core of a coil of  $n$  turns, joined up to a circuit of resistance  $R$ , then the quantity  $q$  of electricity produced in the circuit will be

$$q = \frac{n l}{R} \quad (1)$$

Also, if an E.M.F., capable of producing a steady current  $C$ , is put in a circuit, then each time the current is started a quantity of electricity

$$q = L \frac{C}{R} \quad (2)$$

will be kept back that would have been generated but for the existence of the coefficient  $L$ .

Owing to this factor  $L$  impeding the starting of the current in the circuit in a similar manner to that in which the inertia of a body opposes the force setting it in motion, it has been aptly called the electro-magnetic inertia of the circuit. But the shorter but less expressive term of inductance is now more generally used.

The quantity  $q$  in (1) is quite unaffected by the presence of any other circuits upon the same electro-magnet. For if  $l_1$  of the same lines of induction are threaded through another coil of  $n_1$  turns, then the quantity

$$q_1 = \frac{l_1 n_1}{R_1} \quad (3)$$

will be induced in this second circuit while  $q$  remains unaltered.

Also when the current,  $c$ , is started in the primary circuit the quantity

$$q_1 = m \frac{c}{R_1} \quad (4)$$

will be induced in the secondary circuit, while the value  $q$  in (2) will also remain unaltered.

From (1) and (2) we get

$$l = c \frac{L}{n}. \quad (5)$$

And, thus, the number of lines of induction threaded through a coil can be determined when the inductance and number of turns upon the coil are known.

Also from (3) and (4)

$$l_1 = c \frac{m}{n_1} \quad (6)$$

And from (5) and (6) we get

$$\frac{l_1}{l} = \frac{m}{L} \frac{n}{n_1}. \quad (7)$$

A formula by which can be determined the fraction of the whole number of lines of induction generated by the primary circuit that are usefully threaded through the secondary circuit.

If  $l$  equidistant lines of induction cross an area  $a$  then the tension along those lines of induction, that is, the pull across the area  $a$

$$= \frac{l^2}{8 \pi a} = \frac{c^2}{8 \pi a} \frac{L^2}{n^2}. \quad (8)$$

The energy absorbed from the primary circuit in generating the lines of magnetic induction through the core of a simple electro-magnet  $= \frac{E q}{2}$  where  $E$  is the E.M.F. of the battery.

From (1) and (2)

$$\frac{E q}{2} = \frac{c n l}{2} = \frac{L c^2}{2} \quad (9)$$

To get as great a pull with as little expenditure of energy as possible in creating the lines of magnetic induction, we must make the quotient of (8) and (9) a maximum

$$\frac{l}{4 \pi a c n} = \frac{L}{4 \pi a n^2} \quad (10)$$

This last expression is useful in the construction of rapidly responding apparatus such as telegraph relays. But in other apparatus it is necessary to get as great a pull with as small a rate of expenditure of heat in the coils as possible; in that case

$$\frac{L^2}{8 \pi a n^2 r}$$

must be made a maximum, where  $r$  is the resistance of the coils of the electro-magnet.

The energy expended by a battery of E.M.F.,  $E$ , during a time,  $t$ , sufficiently long to admit the current arriving at its permanent state

$$= E (c t - q) \quad (11)$$

where  $q$  is the quantity of electricity damped back by  $L$  on starting the current.

Filling the value of  $q$  in (2), in (11) the energy expended by the battery becomes

$$\frac{E^2}{R} \left( t - \frac{L}{R} \right) \quad (12)$$

But since from (9) the part of this energy absorbed from the primary circuit in creating the magnetic field

$$= \frac{E^2}{R} \frac{L}{2 R}$$

It follows that the difference between the values (12) and (9) gives the amount expended in heat

$$= \frac{E^2}{R} \left( t - \frac{3 L}{2 R} \right) \quad (13)$$

If there is no secondary circuit this heat will be expended by the current in the primary circuit. But if a secondary circuit exists part of this heat will be expended in that circuit also.

If the same lines of induction are discharged through several secondary coils then the energy embodied in the lines of induction will be divided between the several coils in proportion to the number of turns of each, and inversely proportional to their resistances. Thus the energy expended in the coil of  $n_1$  turns and resistance  $R_1$  would be

$$\frac{E^2}{R^2} \frac{L}{2} \left( \frac{\frac{n_1}{R_1}}{\frac{n_1}{R_1} + \frac{n}{R}} \right)$$

Obviously it is immaterial whether the coil of  $n$  turns is a secondary or a primary circuit, and since  $\frac{E^2}{R^2} \frac{L}{2}$  is the energy embodied in the lines of induction threaded through the two coils, the sum of these last two values, or

$$\frac{E^2}{R^2} \frac{L}{2} \left( \frac{2 \frac{n_1}{R_1} + \frac{n}{R}}{\frac{n_1}{R_1} + \frac{n}{R}} \right)$$

will represent the energy absorbed from the primary circuit on starting the current.

Thus it will be seen that the whole energy taken from the primary circuit on starting the current cannot be twice as great as when there is no secondary circuit, but approaches more closely to that value as  $\frac{n_1}{R_1}$  becomes

great as compared with  $\frac{n}{R}$ .

The time of discharge is important in induction phenomena, as it is by the variation of this factor that the laws of conservation of energy are maintained. Let  $t$  be a time of sufficient duration to include nearly the whole of the discharge. And  $e$  and  $e_1$  the mean E.M.F. in the primary and secondary circuits during this time, then

$$e = \frac{n l}{t} = \frac{L c}{t} \quad (14)$$

$$e_1 = \frac{n_1 l_1}{t} = \frac{m c}{t} \quad (15)$$

And the energy given off in the discharge of the secondary circuit

$$\begin{aligned} &= e_1 q_1 = \frac{n_1^2 l_1^2}{t R_1} \\ &= \frac{m^2 c^2}{t R_1} = \frac{E^2}{R^2} \frac{m^2}{t R_1} \end{aligned} \quad (16)$$

By adding this last quantity to the energy expended in creating the magnetic field and to that expended in heat in the primary circuit, and equating the result to the energy expended by the battery, the value of  $t$  can be determined.

For purposes of illustration, the use of differentials may be avoided by taking proportionality only. Thus :

$$\frac{E(E-e)t}{R} \propto \frac{(E-e)^2}{R} t + \frac{E^2}{R^2} \frac{m^2}{t R_1} + \frac{E^2}{R^2} \frac{L}{2}$$

Filling in the value of  $e = \frac{Lc}{t} = \frac{E}{R} \frac{L}{t}$  we get

$$t - \frac{L}{R} \propto \frac{\left(t - \frac{L}{R}\right)^2}{t} + \frac{m^2}{t R R_1} + \frac{L}{2 R}$$

$$\therefore t \propto \frac{2}{L} \left( \frac{L^2}{R} + \frac{m^2}{R_1} \right)$$

It can be shown by Helmholtz's well-known exponential equation that this value of  $t$  is equal to the time occupied by .865, or nearly  $\frac{9}{10}$ ths of the discharge. So that we may say

$$t = \frac{2}{L} \left( \frac{L^2}{R} + \frac{m^2}{R_1} \right) \quad (17)$$

If there is no secondary circuit or if  $R_1$  is infinite

$$t = 2 \frac{L}{R} \quad (18)$$

Also if the discharge takes place in the secondary circuit when the primary circuit is broken.

$$t = 2 \frac{m^2}{L R_1} \quad (19)$$

There is an important difference between the discharge of a condenser and that of a simple electro-magnet.

The current produced by the discharge of a condenser for similar phases of the discharge is inversely proportional to the resistance, and the time of discharge varies directly as the resistance.

But in the case of the discharge of the coil the current for similar phases of the discharge is independent of the resistance while the time of discharge varies inversely as the resistance.

So that in the former case the product of the time of discharge and the current, that is, the quantity  $q$  is constant, while in the latter case, the product of the resistance and the time of discharge is constant, and the quantity of the discharge varies inversely as the resistance.

Again, in the case of the condenser, the E.M.F. at similar phases of the discharge is constant, while in the case of the coil it is proportional directly to the resistance and inversely proportional to the time of discharge.

But while the initial current and current for similar phases of the discharge are constant when there is but one circuit surrounding the same lines of induction, yet this is not the case when there are several such circuits. This evidently follows, since the quantity of electricity of the discharge from each circuit is not influenced by the presence of other circuits, while the time occupied by the discharge is affected as shown in formulas (17), (18), (19).

Thus, the initial current and current for similar phases produced in the secondary circuit on closing the primary would be but

$$\frac{\frac{m^2}{R_1}}{\frac{L^2}{R} + \frac{m^2}{R_1}}$$

of that produced in the secondary when the primary circuit was broken.

In the same manner, the initial value of the imaginary inverse current, or to speak more correctly, that of the opposing E.M.F. in the primary circuit, would be

$$\frac{\frac{L^2}{R}}{\frac{L^2}{R} + \frac{m^2}{R_1}}$$

of what it would be if no secondary circuit existed.

Hence the presence of a secondary circuit has the effect of making the opposing E.M.F. in the primary circuit smaller in amount for similar phases of the discharge. But the discharge occupies a proportionately longer time so as to maintain the quantity  $q$  of the discharge constant.

Since the value of the current in the primary circuit, where no secondary circuit exists, starts at 0, and rises to  $c$ . Therefore the imaginary inverse current must start at  $c$  and fall to 0.

Similarly if the discharge takes place through the secondary circuit when the primary circuit is broken, the values of the initial current will be

$$c \frac{n_1 l_1}{n l} = c \frac{m}{L}$$

Hence the initial value of the secondary current on closing the primary circuit will be

$$c \frac{m}{L} \left( \frac{\frac{m^2}{R_1} + \frac{L^2}{R}}{\frac{m^2}{R_1} + \frac{L^2}{R}} \right)$$

And the initial value of the opposing E.M.F. in the primary circuit on starting the current will be

$$E \left( \frac{\frac{L^2}{R}}{\frac{L^2}{R} + \frac{m^2}{R_1}} \right)$$

This phenomena presented by the ordinary spark coil depends upon this law of the time of charge and discharge of the coil being proportional to the conductivity of the circuit surrounding it.

For when the primary circuit of the coil is closed, owing to the primary resistance being very small, the time of charging the coil is great, and the E.M.F. induced in the secondary coil not sufficiently great to produce a spark. But when the primary circuit is broken there exists an electro-magnet surrounded by a secondary coil of many turns, but of very great resistance owing to the air space between the discharging points; therefore, the lines of induction collapse very rapidly and charge the poles of the secondary coil to a very high potential. And when the static charge upon the poles of the secondary coil reaches a sufficiently high potential, a discharge takes place and the energy embodied in the lines of induction through the core disappears in the spark so produced.

At any instant of time the ratio of the E.M.F. induced in the secondary to that induced in the primary coil will be

$$\frac{n_1 l_1}{n l} = \frac{m}{L}$$

The length of spark produced in the secondary circuit will, however, not depend directly upon the E.M.F. induced in the secondary coil, but upon the static potential at the discharge points, which will be somewhat less than the induced E.M.F. owing to the static capacity of the ends of the coil and the discharge points.

It is a familiar induction coil experiment to join a condenser to the two poles of the secondary coil, and thus, by reducing the static potential of the discharge points to obtain shorter sparks, but of greater volume, in proportion to the capacity of the added condenser.

The function of the condenser attached to the primary coil of all induction coils, is also, of course, to reduce the static potential at the contact points, and thus prevent sparking.

In some shocking coils, the severity of the shock is regulated by thrusting a copper or brass tube over the iron core. The function of this tube is twofold, as besides absorbing a portion of the energy given off by the primary circuit, it also reduces the rate at which the lines of induction through the core collapse, and thus reduces the induced E.M.F. in the secondary circuit.

## SMITHFIELD CLUB SHOW.

AT this show, held during the current week, the leading makers displayed some excellent specimens of steam engines, specially designed to combine the requisites of a good prime motor for electric lighting. At the stand of *Messrs. Marshall, Sons & Co.* is exhibited a 10 H.P. nominal compound stationary steam engine, erected underneath a locomotive multitubular boiler. The equipment includes Hartnell's patent automatic expansion gear, automatic sight feed lubricator, and a steam trap for draining the cylinder jackets. The engine and boiler are constructed of ample strength for a working pressure of 140 lbs. to the square inch, and are specially adapted for electric lighting. They also showed two engines worthy of special attention, one of which is a new pattern (Class "M") independent vertical engine, cylinder  $6\frac{1}{2}$  inches by 10 inches, fitted with *Moore's* patent crankshaft governor, and automatic cut-off balanced slide valve, and a patent automatic sight feed lubricator, &c. The engine is specially adapted for electric lighting, there being ample provision for lubrication, and the governor controlling the engine to such a nicety, that there is practically no variation in the speed, however much the load may change. The other is a self-contained engine of the horizontal type (Class "M"), with cylinder 10 inches by 14 inches. The equipment of this engine is exactly similar to the vertical named above, with the addition of forcepump. This is also specially adapted for electric lighting or other machinery requiring steady running.

*Messrs. Robey & Co.* exhibited a compound "Robey" engine and locomotive boiler combined, of the type so largely used for electric light installations, and for driving other machinery where perfectly steady running is required. It is very powerful for the space occupied, works with perfect regularity with very varying loads, and is extremely economical in fuel, consuming under 2 lbs. of best Welsh coal per indicated horse power per hour. The working parts are perfectly balanced, so as to run safely at high speed, and as they have large wearing surfaces of ample size they run cool under heavy loads. It is well lubricated for long runs. At this stand is also shown a high speed vertical engine, specially designed for working electric light machines on board ship, and in flour mills, but it is equally suitable for any other purpose where great power is required in small space. It is designed to work with a high steam pressure, and may be arranged to run at various speeds as may be most suitable for the work it has to do. All the wearing parts have very large surfaces, and it is fitted up with means for self-lubrication, so that it may run continuously, without any risk of heated bearings. While every part of it is thoroughly well lubricated, it is so arranged that no oil is wasted. When used for electric lighting it is mounted on a cast iron bed plate, the other end of which carries the dynamo. The baseplate is provided with lugs and adjusting screws, so that the driving bolt can be tightened without stopping the machinery. The engine is perfectly balanced, so as to run at a high speed, without excessive wear, and the whole forms a strong, durable, and compact motor, which can be thoroughly relied upon to work economically and safely during long runs, without giving trouble. Another class of engine represented is the "long stroke horizontal fixed engine," fitted with patent automatic expansion gear. This engine is designed for high pressure of 80 lbs. to 100 lbs., and is provided with steam-jacketed cylinder, with liner made of specially hard close-grained metal, extra long crank-shaft, with long bearings, solid end connecting rod, and all working parts of ample size and strength to work continuously with pressure of from 80 to 100 lbs. steam. It is fitted with Richardson's patent automatic gear and governor, which gives a range of admission from zero to three-quarters of the stroke, and a very perfect distribution of steam. A "horizontal fixed engine" was also shown, fitted with patent trip expansion gear (Class "E"). When steam engines are of large size, and work with steam of high pressure, the

working of the slide valves becomes an appreciable part of the load upon the engine, and to obviate this various kinds of equilibrium valve gear have been introduced, the best known among them being the Corliss, with rotating valves, and the Sulzer, with Cornish double beat valves, a variety of which is known as the Proell gear. All these gears are manufactured by Robey and Company, and can be fitted to their engines when required; but their large experience with the different varieties has enabled them to discern the weak points in each kind, and as a result they have produced a patent trip expansion gear, which is the simplest, most effective, and most easily worked, and gives the most satisfactory results of any hitherto made.

*Messrs. Hornsby and Sons* showed one of their under type stationary compound engines of 10 H.P., fitted with loco. type boiler, which are in use largely both at home and abroad for electric lighting owing to their economy in consumption of fuel, steadiness of running, and the small amount of space occupied. This engine is fitted with Hornsby's patent automatic expansion gear, and also feed-water heater. A vertical engine for high speed is also worthy of notice. This is of 4 nominal H.P., and is specially designed for electric lighting purposes on board ship and other places. This engine, when driving a suitable dynamo, is capable of running 80 to 100 16-C.P. incandescent lamps, and is of course also suitable for any purpose where a high speed and great power in small space are required.

Amongst the engines shown by *Messrs. Ransomes, Sims and Jefferies*, and by *Messrs. Ruston, Proctor and Co.*, there were also several particularly adapted for driving electrical machinery, of some of which we have published full particulars on other occasions.

*Messrs. Wilcox & Co.* made a good display, as usual, of machine belting, lubricators, oils, and the large variety of engine-room requisites supplied by the firm.

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## NOTES ON ECONOMY IN CONDUCTORS IN SYSTEMS OF DISTRIBUTION OF ELECTRICAL ENERGY.\*

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IN considering what economies it is possible to introduce into a system of conductors laid down for the distribution of electrical energy, one has at the outset to consider the relative merits of the different systems which have been proposed before investigating the best proportions to be given to different parts of the system fixed upon, and the proper current densities to be employed in them.

With regard to this first question, I do not propose to say more than a very few words, or to deal with it in any but the most general way.

It is important to observe, in the first place, that the pressure to be used in houses for lighting by incandescence lamps has been practically limited to a maximum of 100 to 120 volts by the makers of the lamps, and that the pressure in buildings may not in any case exceed the 300 volts fixed by the Board of Trade. This consideration, while greatly hampering the system of simple parallel distribution, does not affect to any great extent the rival systems employing accumulators or secondary generators.

In his Cantor lectures before the Society of Arts in 1885, Prof. George Forbes gave a very interesting account of various systems and their sub-divisions; and he showed that, except for a very limited area of compact form requiring a large amount of light per unit of area, this system of simple parallel distribution is impracticable on account of the enormous expense of mains to carry the large currents necessitated by the use of so low a voltage. For a very small and compact area such as a block of buildings, it may be worth while to consider the applicability of this system, however, on account of its simplicity and the cheapness of the class of cable that may be employed.

No practical use of the series system for general station work has been made that I am aware of, though, of course, it is largely in use for outdoor lighting and transmission of power. It has the obvious advantage of requiring comparatively small conductors, but against that must be put the expenditure necessary for providing a complete system of automatic cut-outs for every lamp, motor, or other apparatus employed, and the difficulty of regulating with any reasonable degree of economy for the varying numbers of lamps alight on different circuits. The comparatively

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\* Paper read before the Old Students' Association, December 4th, by Hamilton Kilgour, member.

low efficiency of glow lamps for series lighting is also an important reason against the adoption of such a system.

The next system to which attention may be drawn is the series-parallel system, of which the modifications known as the three-wire, four-wire, and similar systems are the most important. These are in general use both in England and abroad, and give for certain distributions of lamps a very good result indeed.

The degree of economy to be obtained with a three, four, or  $n$  wire system over the simple parallel system depends on the certainty or otherwise with which you can rely on a continued balance of load between the different sections. This you would secure as far as possible by putting as many of each class of consumers in each section, and also, if practicable, by insisting upon the wiring of all buildings supplied being upon the same system as that of the mains, and the total load in every case distributed between the sections.

If you are sure that the load in any one section will never exceed that of any of the others by more than  $m$  per cent. of the full load of a section, and the system is one of  $n$  wires; then if  $E$  stands for the percentage reduction in amount of copper used from that necessary in an equivalent simple parallel system,

$$E = 100 \left\{ 1 - \frac{200 + m(n-2)}{200(n-1)} \right\}$$

For example, let  $m = 25$  and  $n = 3$

then  $E = 43.8$ .

If, as in a case in which all the wiring is done upon the same system as that of the mains, we may take  $m = 10$ ; and supposing  $n = 4$ , then

$$E = 63.3.$$

If in the same case we take  $n = 5$ ,

$$E = 71.3.$$

In considering these systems it is necessary, in any practical case, to take into account the increased cost of labour in putting them down, and of the conduits or pipes in which they are enclosed. In connection with this, it is worthy of remark that with underground systems of mains—such as are likely to be in vogue in future—the cost of the actual cables may amount to less than 50 per cent. of the total cost of the cables laid.

With regard to systems employing accumulators or secondary generators, there is at once a great gain in the allowance of very much high pressures in the mains. The cable is, however, very much more expensive, and the cost of the accumulators and their constant inefficiency must be taken into account in the one case, and in the other the cost of the converters and their inefficiency on light loads. In the case of accumulators it is necessary to distribute the energy from sub-stations upon some one of the low tension systems, so that there is only a partial gain in respect to copper; and with converters, and especially those for alternating currents, it is well known that their cost per kilowatt output diminishes to a considerable extent as their size increases, so that with these also it may be and is advisable sometimes to employ sub-stations, so that the same remark will apply here.

I have now very briefly alluded to some of the conditions affecting the relative economies of the chief systems of distribution of electrical energy; and I have purposely refrained from examination of them in detail for the reason that every particular case will differ to some extent from any other, and in making a choice of the system to be employed to best meet its requirements, a special investigation should be made having regard to all the conditions involved.

Before taking up any problems, such as those referred to in the abstract sent out to members, a word must be said as to the relation of price to size of cable. Bare wires, as you all know, are sold at so much a pound in general; stranded cables being a little more expensive than single wires, and wires smaller than No. 20 or 22 a little dearer than those above this size. Speaking generally, however, cables of bare wire of approximately the same cross-sectional area are sold at the same price per pound. Small insulated wires of a definite thickness of insulation, such as one of two layers of cotton or silk, are also often sold at so much a pound, but with these we have nothing at present to do, unless it be to remark that with such wires the insulation resistance necessarily decreases as the wire increases in size.

Insulated cables for use in any of the cases we have to consider are, I believe, invariably sold by length.

For a given class of insulation, and a given insulation resistance per mile, you would expect—seeing that for a given insulation the mass of the insulator is directly proportional to the mass of the copper insulated—that the prices should be very nearly proportional to the cross-sectional areas of the copper conductors. In practice this is very nearly so, for the price of a cable may be expressed by the equation

$$P = a + bA,$$

where  $P$  = cost per mile in pounds

$A$  = area of conductor in  $\frac{1}{1000}$ ths of one square inch and where  $a$  and  $b$  are constants depending upon the class of insulation and the number of strands in the cable, with considerable accuracy with the cables of some of the best known makers.

Taking Silvertown cables for example:

Class L.

7 strands  $P = 10.3 + 3.58 A$  within 2.6 per cent.

19 „ „  $P = 15.7 + 3.39 A$  „ 3.5 „

37 „ „  $P = 22.5 + 3.32 A$  „ 0.7 „

Class D.

7 strands  $P = 4.72 + 1.32 A$  „ 2.9 „  
19 „ „  $P = 7.22 + 1.27 A$  „ 4.6 „  
37 „ „  $P = 12.2 + 1.25 A$  „ 0.4 „

The percentage errors given above are the maxima, and the average are from  $\frac{1}{4}$  to  $\frac{1}{2}$  these.

In a similar way the values of the constants for the other classes manufactured by the Silvertown Company may be tabulated, but I have not thought it necessary to do so here, more especially as I have not their most recent price sheet by me.

With Fowler-Waring cables (lead covered) you would not expect this law to hold with the same degree of accuracy, as the thickness of lead is not proportional to the diameter of the cable. We have, however, for seven-stranded cables  $P = 25.9 + 2.49 A$ , with a maximum error of  $12\frac{1}{2}$  per cent. and an average error of 4.8 per cent.

The cables of Messrs. Siemens are not manufactured upon the plan of having a given insulation resistance per mile for a given class of cable; the insulation resistance of their cables of a given class diminishes as the size of the cable increases. For example, for their classes L, M, and N, the insulation resistance per mile varies from 2,500 megohms for the smallest sizes to 300 megohms for the largest. You would not, then, expect to find the price of a cable proportional to its size, nor, in fact, is it actually nearly so.

With all cables, however, which are very nearly of the same size the price is, of course, very nearly proportional to the cross-sectional area of the copper, and over a narrow range the rule  $P = a + bA$  still holds, the constants in any case being very easily determined by plotting a few points in the neighbourhood of the size you want, and drawing the tangent to the curve (or the chord through points on either side of the size you estimate is about what you require), when the ordinate of the point of intersection of this tangent or chord with the axis of  $y$  gives  $a$ , and  $b$  is the trigonometrical tangent of the angle made by the line as drawn with the axis of  $x$ , it being supposed that prices are plotted as ordinates.

Now, in any case of central station work you can estimate from experience what is approximately the cross-sectional area of copper you want, so that we may take it that, for our purposes, the rule  $P = a + bA$  holds universally. This may be regarded in the light that you pay a sum  $a$  for the privilege of being allowed to buy the cable you require from the makers you are dealing with, and for the rest the price of this cable is directly proportional to its size.

The most economical current density to employ for a constant and uniform current circuit working for a given number of hours per annum.

Let  $a$  = current in amperes;  
 $n$  = number of hours of working per annum;  
 $\rho$  = resistance of conductor of one square inch sectional area in ohms per mile;  
 $c$  = value of the Board of Trade unit in pence;  
 $d$  = sum of the rates of interest, depreciation, and repairs on capital laid out in cable;  
 $x$  = sectional area of conductor required in  $\frac{1}{1000}$ ths of one square inch;  
 $D$  = most economical current density to employ in amperes per square inch;  
 $P = a + bx$  as before;

$$\text{then } x = a \sqrt{\frac{nc\rho}{2.4bd}}$$

$$\text{and } D = 1,000 \sqrt{\frac{2.4bd}{nc\rho}}$$

For copper conductors  $\rho = 0.0425$ , hence

$$x = 0.133 a \sqrt{\frac{nc}{bd}}$$

$$\text{and } D = 7,513 \sqrt{\frac{bd}{nc}}$$

For example, if we take Silvertown class L cable, and

$$c = 5$$

$$d = 13$$

we shall have the most economical current densities for different numbers of hours per annum given by the following table:

$n$	D.		
	7 strands.	19 strands.	37 strands.
400	1,119	1,089	1,077
600	913	889	880
800	791	770	762
1,000	708	689	681
1,500	578	562	556
2,000	500	487	482
3,000	408	398	393

In this table  $\rho$  has been taken as 0.0446, which is rather higher than it should be.

No account of the increased resistance of the conductor due to heating has been taken account of in the foregoing; but as the current density to employ in a given case is known approximately from previous experience after a little, an allowance can easily be made for the probable heating in the value of  $\rho$  you decide to use.

(To be continued.)

It is a very striking example of the recuperative action of a secondary cell that you can completely discharge it, as you think, and then even charge it in the wrong direction, but it will, on being insulated, rapidly recover an E.M.F. in the original direction. Indeed, we were told of a curious case some time back. After the removal of the laboratory employed for testing ammeters from one part of a well-known London factory to another, it was found that the E.P.S. accumulators always ran

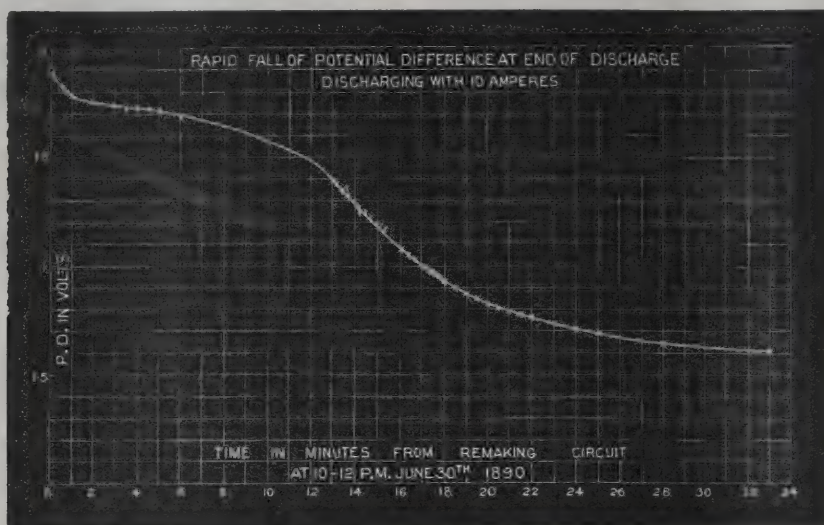


FIG. 10.

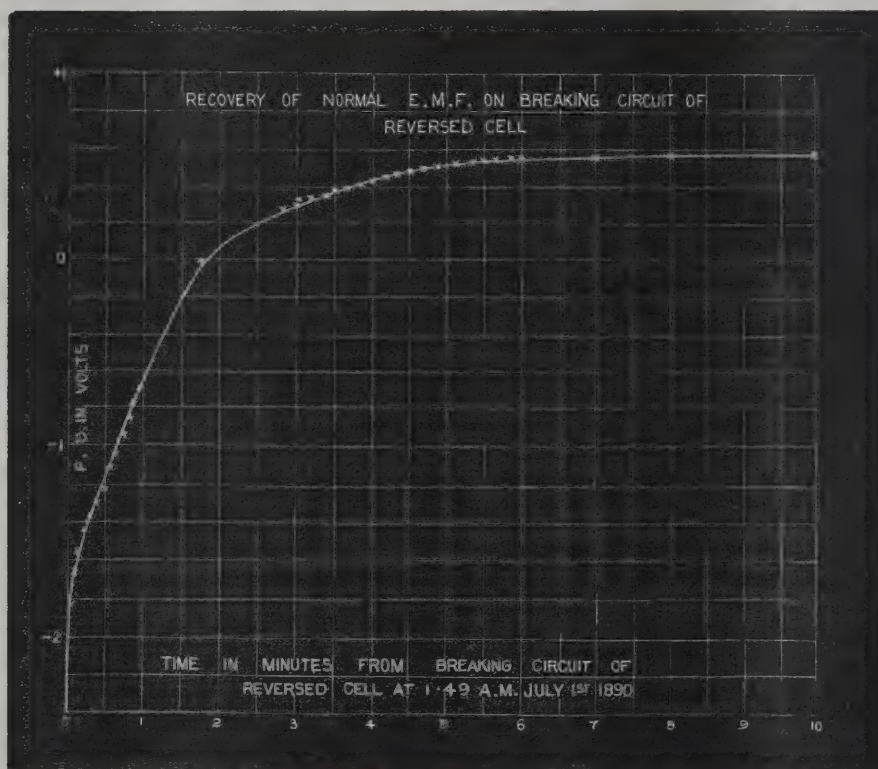


FIG. 11.

## PROCEEDINGS OF SOCIETIES.

### The Institution of Electrical Engineers.

(Continued from page 653.)

As already explained, the constant discharge current of 10 ampères was, by the employment of some auxiliary cells, kept flowing through the accumulator under test even when its E.M.F. became very small. Towards the end of the discharge the fall of P.D. at the terminals of the cell under test became extremely rapid, so that, for example, on closing the circuit after the removal of the plugs at  $\nu'$  (fig. 2), the P.D. fell from 1.9 to 0.6 volts in 33 minutes, as seen from fig. 10. This rapid fall is probably due to lead peroxide being formed on the negative plates more rapidly than it could be removed by local action, since the chemical analysis showed decided evidences of lead peroxide on the plugs removed at  $\nu'$  from the negative plates. At  $\pi'$  (fig. 2) the E.M.F. of the accumulator under test became reversed, but rapidly recovered its original direction on stopping the discharge current, as seen from fig. 11.

down very rapidly whenever an attempt was made to use them, in spite of their having been charged in the intervals. As the E.M.F. was always in the right direction, it was supposed that the cells had become partially short-circuited in the removal, and it was not for some time that the true explanation of the refusal of the cells to do their work was discovered. The real fact was that, in fitting up the new laboratory, the leads from the dynamo to the switch had been reversed, so that the unfortunate cells were charged in the wrong direction every time the dynamo was turned on.

The preceding incident also forcibly illustrates the sort of attention that secondary cells may receive in practice, and shows the necessity for the P.D. and specific gravity being occasionally measured even in places where the study of the behaviour of cells is not the main business of the factory.

One of the great defects of the earlier specimens of the E.P.S. cells lay in the buckling of the plates. Mr. Capito tells us that it was Mr. Collet who noticed that all the plates generally curved in one direction, and who suspected that this arose from the unequal chemical action on the two sides of the last positive plate of the cell. Mr. Collet therefore proposed putting a negative

plate at each end of this cell, and this plan—which has been always followed since—of using one more negative than positive plate, has had much to do with removal of the buckling difficulty.

V.

EFFECT OF REST ON CHARGED ACCUMULATORS.

As the result of a number of tests described in our Edinburgh paper, we found that if E.P.S. accumulators be charged with 9 amperes and discharged with 10, a number of times without intermission, between the P.D. limits of 1·8 and 2·4 volts per cell, until the cells are brought to a perfectly steady "working state" the quantity efficiency is about 97 per cent., and the energy efficiency 87; further, that if the cells be fully charged until the P.D. per cell is 2·4 volts, and then be left perfectly insulated for 16 days, the next discharge between the fixed P.D. limits only gives out about 65 per cent. of the ampère-hours, and about 57 per cent. of the energy put in before the rest. Further, not merely is energy lost during the rest of an insulated accumulator, but for several subsequent charges and discharges between the same P.D. limits after the rest the storage capacity and the quantity and energy efficiencies are all lower than before the rest.

For the purpose of examining into what took place in an accumulator, which was left charged, a small E.P.S. cell was charged until the P.D. was 2·4 volts, and then the positive plates were withdrawn and put into another vessel containing dilute acid of specific gravity 1·2, the negatives being left in the vessel in which they were charged. Both sets of plates were covered up with gutta-percha hoods the edges of which dipped under the liquid, and to the top of each hood was fitted, gas tight, a vertical graduated glass tube closed at the top. The hoods and the glass tubes were first filled with liquid, and the amount of gas that came off from the two sets of plates was measured from day to day by watching the descent of the liquid in the tubes.

No gas was seen to come off from the positive plates, but in the case of the negatives gas came off very slowly at first, then more rapidly, and finally more slowly again. The following table gives a record of the amount of gas that came off from the negative plates, the gas, on analysis, being found to be hydrogen\* :—

Hydrogen Gas Collected from Charged Negative Plates after Removal of Positive Plates.

Date.	Time.		Cubic centimetres of gas collected.	Time of collecting gas, in hours.
	H.	M.		
November 15th ...	11	45	0	0
" 17th ...	10	0	2	46
" 20th ...	12	0	52	120
" 21st ...	10	0	72	142
" 22nd ...	10	0	87	166

If the lead of the positive plate be turned into lead sulphate by local action, 87 c.c. of hydrogen liberated corresponds with about 0·81 gramme of lead turned into sulphate. It is clear, then, that the lead of the negative plate is steadily being turned into some oxide or salt, and probably the loss of energy which we observed in the charged cell left insulated for many days was due to this local action at the negative plate. And further, as this action takes place apparently only at the negative plate, it is clear that in the subsequent discharge the cell will appear to be discharged before the positive plate is discharged, and charged up again without reducing all the lead sulphate on the negative plate. The local action at the negative plate while a cell is standing charged has, therefore, for the first few discharges and charges after a long rest, exactly the same effect as if a portion of the negative plate had been bodily removed out of the cell. Hence we see that the peculiarities observed by us in curves 8 to 23 in our Edinburgh paper may be explained by this defective behaviour of the negative plates.

VI.

CONSTRUCTION AND FORMATION OF E.P.S. PLATES.

The question arises why the E.P.S. accumulators are so constructed that the plugs in the positive plates contain some 48 per cent. more peroxide of lead than is required to be converted into sulphate in the normal discharge. Two explanations suggest themselves. One is that, since the granules of lead peroxide begin, as we find, to be coated with a protecting coating of sulphate early in the discharge, it is impossible, with the present form of plate, for the interior of each granule of lead peroxide to be converted into sulphate, and, therefore, it is necessary to employ nearly twice as much lead peroxide as is actually needed for the chemical action. Another reason is the fear of the positive plate crumbling to pieces if it be completely formed; and this reason Mr. Capito, who was formerly in the employ of the Electrical Power Storage Company, thinks, on the whole, is the more important.

In the construction of the original Faure accumulators, as well as of the early E.P.S. cells, both the positive and the negative plates were pasted with red lead ( $Pb_3O_4$ ), and formed together for a

period of some 50 hours. Later on litharge ( $PbO$ ) was used to coat the negative plate, red lead being used only for the positive one, and the plates were formed separately, the negative being much more formed at the works than the positive. Some time ago I was informed by a very competent authority that the following is the modern process of forming employed by the Electrical Power Storage Company :—

*Positive Plates.*— $8\frac{1}{4}"$  by  $7\frac{1}{4}"$  by  $\frac{1}{4}"$ . Two amperes per plate, or 0·028 ampère per square inch, sent for 18 hours.

*Negative Plates.*— $9"$  by  $9\frac{3}{4}"$  by  $\frac{3}{16}"$ . One and a half to two amperes per plate, i.e., 0·017 to 0·023 ampères per square inch, for 120 hours.

The actual time of forming either set of plates depends greatly on the length of stoppages during the formation. This is especially the case with the negative plates, therefore they endeavour to form the negatives for the 120 hours without any stoppage of the current. On the receipt of a cell from the Electrical Construction Corporation, the purchaser is requested to form it for 40 hours more with the ordinary charging current used in working, which is at the rate of 0·026 ampère per square inch.

Mr. Capito tells us that, when he was at Millwall, such periods of formation as 120 hours were not used; and he thinks that this may be due to the fact that formerly the plates were not dried after pasting and before formation, as they are at present. This drying hardens the plates and produces a better cell; but he thinks that, as the paste is itself mixed with sulphuric acid, there is probably some sulphating of the negative plates during drying, and that several hours in the subsequent formation are probably spent in reducing this sulphate.

The reason, we understand, for the manufacturers only forming the positive plates for 18 hours, and leaving the purchaser to form them for the remaining 40 hours, is that if positive plates be well formed and then dried for carriage, the plugs become loose, which is not the case if the positive plates be only slightly formed before drying.

We were interested in learning from Mr. Capito whether, while superintending the manufacture of many thousands of accumulator plates, he had ever tried pasting the positive with lead peroxide ( $PbO_2$ ) in order to avoid the necessity of having to form this salt electrically out of the red lead with which the positive plates are usually pasted. This idea of applying a paste of lead peroxide directly to the positive plate, he told us, he had tried, but that the method turned out a failure, from the impossibility of getting the lead peroxide paste to stick on to the grid even when some red lead was mixed with the lead peroxide. He also mentioned a very interesting fact—that whereas a paste of red lead mixed with dilute sulphuric acid of density 1·1 gives an adherent deposit on formation, on the contrary, a powdery deposit is produced if the density of the liquid used in making the red lead paste be 1·2. We understand the process that has shown itself the best is to use dilute sulphuric acid of density 1·1 for mixing the red lead paste, and dilute acid of 1·2 for mixing the litharge paste for the negative plates.

Discussion on "The Chemical Action of Secondary Cells," by Prof. W. E. AYRTON, F.R.S., C. G. LAMB, B.Sc., and E. W. SMITH, and on "The Working Efficiency of Secondary Cells," by the same authors and M. W. WOODS.

(Authorised abstract.)

In opening the discussion, Dr. GLADSTONE said he had been greatly interested in the points brought out by the authors, and in the account of the elaborate experiments described. He was rather surprised that taking out so many plugs from the cell had not greatly damaged it. The chemical results arrived at, he considered, confirmed the views put forward by himself and Mr. Tribe about nine years ago, as to the action of cells resulting in the formation and reduction of ordinary lead sulphate. Since that time, however, many statements had been made attributing important functions to sub-sulphates, but so far as he and Mr. Hibbert had investigated the matter, such statements had not been confirmed. They now believe that the so-called sub-sulphates are probably mixtures of ordinary sulphate and peroxide. Referring to the difficulty experienced by Mr. Robertson in analysing the powdered sulphate, he pointed out that ammonium acetate could be used for dissolving out the sulphate. Results obtained by this method showed the sulphate to be the normal one, and he did not think the solvent would alter any sub-sulphates if such were present. In his opinion there could be no doubt but that the sulphate surrounding granules of peroxide would act as stated in the paper and diminish the capacity of the cell. Speaking of the gas given off by the negative plate, he said the fact had been alluded to in a paper by Mr. Hibbert and himself recently published in the *Phil. Magazine*. They, however, had not observed the great differences in the hardness of plugs at different parts of the plates. This result, he considered, very important, and thought it would lead to a modification in the form of plates.

Mr. CROMPTON said that for some time past he had been working on the subject of secondary cells, and had arrived at results similar to those brought forward in the paper. One great advantage, however, of the results contained in the communications under discussion, arose from the fact that they were obtained from cells of a different type from those he had experimented on, for if he himself had brought the results before the Institution, it would have been thought that the actions were peculiar to his kind of cell. As regards the "gassing" of cells, he had found it due in a great

\* Since the preparation of this paper we have noticed that Dr. Gladstone and Mr. Hibbert, in their paper communicated this summer to the Physical Society, have also observed that hydrogen comes off from a charged negative plate of a secondary cell when left idle.

measure to light. Both sunlight and arc light increased this action, and quantitative experiments were now being made. He was glad to see the statements of the advocates of secondary batteries, as regards efficiency, had been confirmed. They had, he said, been accused of exaggerating their efficiency, and not without cause, for the cells themselves behave peculiarly, as, for example, the 105 per cent. quantity efficiency mentioned in the paper. Such results seem impossible, and showed the necessity of getting cells into what the authors had called "the steady working state." He regretted that "proof plates" had not been used in the experiments on the running down of cells. He had used them for a long time, and always found the negative discharged first. If, however, very thick negatives were used, there was no sudden drop in the potential difference such as indicated in figs. 2 and 3. In endeavouring to measure the resistance of cells with a view to determining the best proportions of plates and liquid, he had met with great difficulties, and he now believed that what is usually measured is of the nature of a back E.M.F.; this he supported by saying that the so-called resistance did not seem to vary either with the thickness of the plates or their distance apart, or with the density of the acid. During his investigations a rosy colouration of parts of the liquid had been noticed in some cells; the coloured portions may either appear as strata, lines, or in tree-like forms, and in some cases resemble the shapes of magnetic lines of force. These peculiarities, he hopes, may give some idea of the electric stresses and strains within the electrolyte. The recuperative power of discharged and reversed cells was very marked, for he had observed it in cells that were half charged in the reverse direction, and on cutting up the plates, layers of different materials could be seen. This fact shows how important it is to thoroughly charge cells of the Planté type during formation by reversals. Until quite recently, negative plates had been considered faultless, and the positives blamed for defects which were in reality due to imperfections in the negatives. He knew of no case in which positives had gone bad when their negatives had sufficient capacity; and for this reason the negatives ought to be made thicker or larger than the positives. "Sick cells," he said, get partially sulphated and the negatives run down; when the E.M.F. falls below 1.3, heavy sulphating of the positive occurs, and so-called "irreducible sulphate" is formed. In his opinion the reducibility or irreducibility is merely a question of its position, or of its contact or want of contact with the conducting material. In conclusion, he suggested that E.P.S. cells might be improved by reducing the size of the plugs so as to bring the active material down to the lead backing.

The discussion was adjourned to the 27th inst.

NOVEMBER 27th, 1890.

Mr. CROMPTON directed attention to three diagrams which he had prepared since last meeting. One of these showed the character of the colouration seen in the electrolyte when viewed from the top curved lines or shells, start from the positive plates and turn away as if repelled from the cell terminals. In one cell, which had its + and - terminals at opposite ends, the lines curved towards the middle of the cell, whilst in another, where the terminals were both at the same end, they bent towards the opposite end. The second diagram exhibited the influence of the rate of discharge on the capacity of a cell having eleven 5 lb. plates. When discharged at 1 ampère per plate, its capacity was 300 ampère hours, but at 6 ampères, only about half. The fall of volts was very sudden at the end of each discharge. The third diagram related to the discharge of an experimental cell containing seven 9 lb. plates, and showed that although the capacities were not very different from those of the 11 plate cell, the fall in volts was not nearly so sudden.

Mr. RECKENZAUN said the papers under discussion were very important ones, and contained much that had never been published before; many of the facts, however, were known to those engaged in the manufacture. The question of efficiency, he thought, was not likely to be settled, since, according to the authors, it may vary between 105 and 58 per cent., depending on the previous history of the cells. In his own experiments on the effect of prolonged rest, he had found a similar loss of efficiency, and he believed this to be due to sulphating of the negatives. The negatives were always played out first, and this defect could not be got over by making them abnormally thick, or by increasing their surface; for if thickening be tried, the interior is not acted on, whilst greater surface gives no advantage on account of the material being at different distances. To test the deficiency of negative plates, he had discharged cells as low as possible, and then put the positive with a newly charged negative; from these a fair E.M.F. and discharge were obtained. He had also tried amalgamated zinc instead of a newly charged negative, and got 40 per cent. of the original capacity. These facts account for the existence of 39 per cent. of Pb O<sub>2</sub> in the positive plugs when the cell was supposed to be completely discharged. In his opinion it would be better to say that the negatives discharged about 30 per cent. too soon. The negatives of Planté cells, especially those formed by the nitric acid process, soon lose their virtue, and this was attributed to the difficulty in removing all the forming acid. In the course of his remarks Mr. Reckenzaun said he had received a very interesting diagram from his brother in America, showing the E.M.F., current, density of acid, temperature of cell and of surrounding air, &c., during the charges and discharges of a secondary battery; this diagram he would place in the hands of the secretary.

A communication from Mr. HALL was then read. This related

to a pair of E.P.S. plates recently taken from the battery under his charge at the P. and O. Company's offices, where they had been in constant use for 6 years. During that period the cells had supplied about 150,000 ampère hours and were still in good condition, as was indeed evident from the appearance of the plates shown. In the working of the battery, the density of each cell had been carefully watched, and any defect promptly removed. His experience confirmed the observations of the authors on the effect of rest.

Mr. W. HIBBERT referring to the Edinburgh paper said he would first deal with the explanation of the high E.M.F. at the end of a charge, and its rapid fall on breaking the circuit. In a communication made to the Physical Society last June, Dr. Gladstone and himself had shown reason for believing this to be due to concentration of acid about the positive plate and subsequent rapid diffusion, and he thought the results plotted in fig. 6 of the paper under discussion, showing the effect of making and breaking the circuit of a charged cell on its E.M.F. and P.D., were consistent with this idea. Further on in the same paper the authors say that the concentration hypothesis will not explain the rise of P.D. in a cell discharging after a long rest; on this point he, Mr. Hibbert, said that the reactions in such states were very complex, but still he thought it would be possible to find an explanation of this phenomenon based on similar lines. Referring to the latter paper, he thought the authors had rather exaggerated the effect of peroxide on the negative plate in causing the volts to fall, for in his own experiments only a small quantity was formed. The simultaneous weakening of the acid round the plates would tend to give a rapid fall in the E.M.F. and the effect of both these actions must be studied if the subject is to be properly understood.

Dr. E. FRANKLAND said he had read the papers with great interest and considered them most important contributions on the subject. In one place the authors deplore the lack of knowledge of the chemical action in cells, and not without reason, he, however, thought physicists were more to blame than chemists, for the physical actions could be readily determined, whereas the chemical changes present formidable difficulties. The substances used and produced were mixtures, and it was very difficult to separate and analyse them, without producing decompositions. A valuable part of the communication was that relating to the quantity of Pb O<sub>2</sub> formed and decomposed during the working of cells. On this point he thought the values put down for Pb O<sub>2</sub> may be either the sesqui- or the three-quarter-oxide, and, in fact, the crux of the whole subject lay in the exact nature of the compounds formed. Dr. Gladstone and himself had apparently arrived at different conclusions, but their differences might admit of explanation, if care and time were taken in considering the matter. Another important point was the quantity of SO<sub>2</sub> absorbed during discharge, viz., 3.08 grammes per ampère hour. If this be translated into hexabasic acid, which he believed to be present, it gives 5.71 grammes. From his own experiments on a 10-plate cell, he had found about 4.7 grammes of hexabasic acid absorbed per ampère hour, whilst discharging at an E.M.F. averaging 1.9 volts, but when the cell was run down and discharged at an E.M.F. averaging 0.3 volt, he found the rate about 3.3 grammes. He did not wish to put these numbers in conflict with those obtained by the authors, but he was strongly impressed with the idea that the two different quantities 4.7 and 3.3, pointed to the existence of two distinct chemical reactions, one resulting in an E.M.F. of about 2 volts, and the other of .3 volt.

Mr. F. KING said the results of the tests were very gratifying to the makers of cells. He commended the skill and ingenuity displayed in devising the automatic apparatus, for the labour involved in working a laboratory day and night without such apparatus is enormous. The inequality of current distribution over the surface of the plates was, he said, well known, and the hanging type of cell was devised to remedy this defect. The first form of this type was abandoned, but more recently they had made another form, one of which was exhibited at the meeting. The current is led into the positives at two points on the top and leaves the negatives at the bottom. With this cell they had doubled the normal rate of discharge without diminishing the capacity and also obtained a longer life. Moreover, the loss of capacity for high rates of discharge, due to the shrinkage of the negative paste and which is so marked in ordinary types, had been avoided. The positive plates somewhat resemble those of the Tudor cell, having deep horizontal grooves along each side in which the active material is placed. The negatives are made according to Sellon's invention, in which a kind of double grid is used, the parts being displaced diagonally so that each plug on one side communicates directly with four plugs on the opposite side and through them with every other plug in that division of the plate. This construction causes any shrinkage of the paste to bind itself more firmly on the grid. As a result of tests on the new cell it has been found that the capacity is greater after 500 or 600 discharges than at the beginning, whereas that of ordinary cells is considerably reduced by 400 discharges. The life of negative plates he believed was not well understood, but with reference to positives he said that those used on tramcars (nine plates 8" x 9½") had a useful life of 70,000 ampère hours. After one year's use their capacity is reduced 83 per cent. Speaking of the resistance of battery connections, he pointed out the advisability of burning the lugs together so as to give as complete a metallic surface as possible. Respecting the pasting and formation of E.P.S. plates, referred to in the second paper, he said that the particulars there given were totally wrong.

Mr. SWINBURNE thought there had never been any solid reason for doubting the formation of normal lead sulphate. The old

ideas about reduction and oxidation that had obscured the subject until Dr. Gladstone and Mr. Tribe brought people to order about eight years ago. The difficulty of reducing ordinary sulphate electrically had been given as a reason why it could not be formed, but now its reduction or non-reduction was known to be a mere question of making contact with it. Seven years ago he had brought forward a theory that the sulphate is not a secondary product at all, and that the output of a cell is mainly dependent on the affinity of sulphur for lead. This, together with the other chemical actions, leaves some E.M.F. to be accounted for by Peltier effects, and these effects would show in the temperature coefficient. He was not aware whether calorimetric data had been obtained for the subsulphates which Dr. Frankland supposed to be present, but, if so, then by working backwards evidence for or against their existence might be procured. The action of finely divided lead on sulphuric acid had, he had, been known for years, and this limited the best strength of acid to about 1 in 4. As regards the equilibrium between the plates of a cell, he was inclined to attribute this either to the absence of  $PbO_2$  from the positive, or of spongy lead from the negative, rather than to the presence of  $PbO_2$  on both plates. He also thought the percentage of material really active was much less than that stated in the paper, for in some experiments of his own he had only found about 8 per cent. useful. Speaking of Mr. Crompton's colour observation, Mr. Swinburne said they were due to ferric acid formed by the action of  $PbO_2$  on iron salts in the commercial acid. In his opinion the virtue of sulphate of soda had been greatly exaggerated, and he believed its action to be due to its enabling bad contact sulphate to be reached more easily.

Sir D. SALOMONS said he had noticed colouration in one or two of his cells, but had attributed them to impurities. The unequal action on different plugs had been to him a subject of common remark, and he had taken steps to equalise the distribution of current by burning on strips of lead, with good results. The bending of negatives could be prevented by building up the sections rigidly. His experience with soda differed from that of Mr. Swinburne, for he had found caustic soda, in the proportion of one ounce to six gallons, very advantageous. Cells supplied with this electrolyte had been left charged for six weeks without injury, and had commenced to boil freely ten minutes after the charging current was started. With ordinary acid, two or three hours charging would be required to produce the same results. In his opinion, makers give extreme limits for the so-called normal working rates of cells, and if these were divided by 2 or 3, better results would be obtained, and would be cheaper in the long run. As regards efficiency, he thought 70 per cent. to be a very fair average. The large amount of  $PbO_2$  not acted on, resulted from the interior of the plugs being, as it were, waterproofed by the sulphate outside. On this account thick plates possessed little or no advantage. Increasing the quantity of electrolyte, however, gives more capacity up to a certain point, but when the plates are put far apart the loss of volts becomes serious. Speaking of pasting positives with  $PbO_2$ , he said he had made good plates in this way by using very strong acid (nearly pure) in making the paste.

Mr. BERNARD DRAKE, whilst adding his testimony to the value of the papers, thought he ought to mention one or two points of detail which might lead to wrong conclusions. For example, the loss of efficiency due to rest might lead clients to suppose that their cells ought to be used even when they were away from home. This, he said, would be a great mistake, for the loss of capacity is due to the negatives; whereas the repairs were chiefly restricted to the positives, whose lives are inversely proportional to the amount of use. In a paper read before the British Association in 1886, he and Mr. Gorham had shown that the whole success of storage cells depended on whether the positives could be made to last a reasonable time, and to effect this it had been found necessary to overcharge them. The actual plates sent by Mr. Hall from the P. and O. offices had been badly sulphated some time ago, and were condemned; he, however, recommended overcharging, with the result now known. In these cells the density of acid used to be from 1,350 to 1,400, and although he did not now recommend such a high specific gravity, yet he thought the subject required more attention than it had received. As to the proportions of the plates, he said the negatives were intentionally made to give out first, so that the positives might not be run down, for a kind of protecting coating is formed on the positives by charging and this is removed by discharging them below a certain point. If this coating is continually reformed the plates expand and buckle and the plugs eventually drop out. Speaking of the cooling action during discharge and also after charging has commenced, he did not see any explanation excepting perhaps that it might depend on the same cause as the rise of specific gravity which occurs after a charging has stopped. This he had found to be due to the heavy acid formed during charging falling to the bottom of the cell and afterwards diffusing into the general body of the liquid, thus affecting the hydrometer. In this connection he enquired whether the temperature was taken at the top or bottom of the cells. The rise of E.M.F. during the first part of a discharge after rest he attributed to the surface of the negatives being coated with a sulphate which was reduced by the discharging current. In reference to the shrinkage of negatives mentioned by Mr. King, he said that in order to avoid blistered negatives a mixture of litharge and sulphate had been used for pasting instead of litharge only. This method although it prevented blistering, necessarily left the plugs of a porous nature, and was liable to permit shrinkage.

The discussion was adjourned to the 11th December.

## LEGAL.

**Watt v. Maxim-Weston Electric Company.**—The matter in dispute between Mr. Watt and The Maxim-Weston Electric Lighting Company were at last settled, on Monday last, by arrangement between the parties. Mr. Watt had claimed £1,623 for salary, commission on the profits of the company, compensation for wrongful dismissal from his position of managing director, payment of rent, and other moneys. A cross action was brought by the company, and it was alleged that Mr. Watt had been general manager upon whose representations the other directors and the auditors relied, and that the accounts purporting to be profit and loss were made out by him. It was also stated that these accounts were untrue, having been made to appear as large as possible so that he could draw 5 per cent. commission, and that upon them plaintiff received larger sums than he was entitled to. Further, it was alleged that he had sent out goods to agents abroad which were not sold, but which were treated by plaintiff as actual sales, and also that bad debts had been entered as good. At Mr. Justice Romer's suggestion the two actions were treated as one and tried together.

The hearing of the case lasted three days, and the judge finally suggested that this was a case where, instead of going through the items one by one, a general sum should be arrived at between the parties, and proposed that he should rise for a short time with a view of counsel seeing whether that could be done.

Counsel on both sides assented to the suggestion, and, after an absence of half-an-hour, his lordship returned into Court, when

Mr. Rigby announced that they had arranged everything as between the company on the one side and Mr. Watt, whether properly raised in actions or not. Watt was to pay the liquidator certain sums standing to his credit in respect of shares purchased by the liquidator, and £330 14s. which stood to a joint account, would be paid to the company, together with the sum of £669 6s. standing to a joint account, and making up £1,000. The actions had got very much mixed up together, but Mr. Watt would pay the taxed costs between party and party in both actions. Mr. Watt would not pay any costs in the winding-up, but included as proper costs in the action were the costs of the motion, directed by the Registrar. The matter was a final settlement of all claims down to this date between the company and the liquidators on the one side and Mr. Watt on the other, whether properly raised in these actions or not, so as to prevent any further litigation.

## REVIEW.

*Electric Light, its Production and Use; Embodying Plain Directions for the Treatment of Dynamo-Electric Machines, Batteries, Accumulators, and Electric Lamps.* By G. W. URQUHART. Fourth Edition. London: Crosby, Lockwood and Son.

The third edition of this work was noticed by us in January of this year, and in reprinting a fourth, the opportunity has been taken of adding two new chapters, "Notes on Ship Lighting," and "Electric Light Wiring Tests." Twelve new illustrations have also been added. Mr. Urquhart's books are written for workmen, and like most works of the kind, are not free from errors, when judged from a scientific standpoint. They are, however, better than most popular works of the same class. Referring to the new chapters, the author's ideas of insulated cables are decidedly crude; and his descriptions of the methods of testing are not likely to afford much help. A mistake is made in explaining the lamp test for earth leakage. We fear that a good deal of the information in these chapters has been derived from published papers and articles rather than from practical experience.

**Obituary.**—M. A. Bède.—We regret to announce the death, in Brussels, of M. Armand Bède, son of M. E. Bède, the well-known Belgian electrician and engineer. The deceased was one of the most distinguished engineering students at the Brussels Polytechnic School, and had already made himself a name by important electrical installations in Russia and Italy and also in Belgium, where he was obliged to return three years since on account of weak health. This gentlemen's death is the cause of much sympathy among Brussels engineers, who had for several years unanimously elected him their vice-president.

## ELECTRIC LIGHTING PROGRESS IN LONDON.

THE paper on this topic, read by Mr. Frank Bailey, before the Society of Arts, is a summary of the present position of things. The paper contains a general history of electric lighting in London, with details of systems adopted. Private plants work about 80,000 32-watt lamps in addition to the supply companies. Mr. Bailey showed table, a copy of which Mr. Bailey has kindly sent us, will be found very interesting:—

## ELECTRIC LIGHTING COMPANIES IN LONDON.

Name of company.	Capital (nominal).	Number of years in existence.	Stations.	Total H.P. engines.	Number of lamps equivalent to 32-watt lamps now connected.	System.	Length of conduit, pipe, or s.w. cable run of main.	Lamps per m. l.c.	Meters.	Districts.
	£						Miles		Number.	Type.
St. James, St. George, Chelsea, Rotherhithe, Bermondsey, St. Mary, Newington, Lambeth (part of), St. Martin's-in-the-Fields (part of). Bill, 1889 ...	1,250,000	5	Deptford	...	38,000	Alternate current transformers (Ferranti)	...	...	136 Ferranti (mercury)	Parishes of:— Clerkenwell (part of) St. Martin's
St. Margaret and St. John, Westminster—Greenwich dis. St. Olave's district ...	...	...	converting stations	...	...	...	...	...	174 Ferranti-Wright-Borel 14 Frager	
St. Saviour's district ...	...	...	...	...	...	...	...	...	...	
The Board of Works of St. Giles' district, Holborn district ...	500,000	2½	Whitehall	600		Direct current & batteries	...	...	...	
Strand district, 1889 ...	...	...	Sardinia Street	3,000	44,598	Alternate current trans. (Westinghouse)	...	1486	378 Schallenberg	Mid. London Or.
Parish of St. Marylebone, 1889	...	...	Rathbone Place	1,200		" (Parker)	...	...	25 Aron	W. London Order
" " Paddington, 1890 ...	...	...	Manchester Square	2,000		"	...	...	...	Paddington Or.
St. Mary Abbot, Kensington—2 portions of ...	350,000	2	West Brompton	600		" Lowrie-Hall	8½	1517	{ 71 Lowrie-Hall 168 Westinghouse	Parish of
Belgravia and Mayfair ...	214,765	2	Millbank Street Dacre Street Eccleston Place Davies Street	temporary station now in progress " " " "	{ 7,540	Direct current & batteries	...	...	93 Aron	Westminster
Kensington and Knightsbridge	300,000	4	Kensington Crt. } Chapel Place }	1,560 and Howell Bttrs.	24,850	" (Crompton)	10½	2306	{ 200 Aron 90 Hookham 34 Aubert	Central
St. Mary Abbot, Kensington—portion of ...	108,000	6	Draycott Place and 3 distributing	Batteries, E.P.S. stations	{ 19,500	Direct current & batteries (King)	...	published in the <i>Engineer</i> , October 24th, 1890	...	Parish of
St. Mary Abbot, Kensington—portion of ...	100,000	1	High Street	nearly complete	and another station not yet commenced		...	...	...	"
St. James' ...	100,000	2½	Duke Street	1,960	23,174	Direct current	4¼ miles	5452	190 Aron	"
St. Pancras	...	...	Stanhope Street	now in progress		"	...	...	...	"
St. Martin's-in-the-Fields	...	...	Strand	658	8,500	"	...	...	— Frager	"
			Total		179,060 lamps equivalent to 32 watts each.					

## PARLIAMENTARY NOTES.

*Railway Signalling.*

IN the House of Commons, on Friday, in reply to Captain Price, Sir M. HICKS-BEACH said: The subject of automatic electric signalling on railways has frequently engaged the attention of the Board of Trade, and further inquiries are now being made. There are many difficulties to be contended with, and all I can say at present is that the matter will continue to receive attention. It may be added that the Norton-Fitwarren collision would not have been prevented had the system, as hitherto carried out, been in force there.

*Licences for Telephone Exchanges.*

In the House of Commons on Monday, Dr. CAMERON asked the Postmaster-General whether, in view of the fact that the patent for the telephone in use by the company which possesses a practical monopoly of telephonic communication in Great Britain had now expired, and in view of the numerous complaints on the part of the public as to high rates and faulty service resulting from that monopoly, he would, with as little delay as possible, make known his decision as to applications for licenses submitted to the Post Office by proposed competitors desiring to introduce loud-speaking and long-distance telephones, and other forms of improved instruments.

Mr. RAIKES: In reply to the hon. member, I have to say that I trust that I may be able at an early date to announce the decision of the Government with regard to licenses for telephone exchanges. It should be borne in mind that the patents for the more important telephones have not expired, and do not expire until July in next year.

*Electric Lighting in London.*

Mr. R. CHAMBERLAIN asked the President of the Board of Trade whether his attention had been called to the long-continued default of the Chelsea Electric Supply Company to furnish the statutory current of 100 volts, and to the serious loss of illuminating power sustained by consumers in consequence; and whether he would take steps to compel this company to keep faith with the public or forfeit their concession.

Sir M. HICKS-BEACH: Last winter the hon. member complained to the Board of Trade of the deficiency in the standard pressure of the current supplied by this company. The Board of Trade communicated with the company, and were informed that the cause of complaint had been removed. Under the regulations imposed upon the company under their order they are bound to declare to the consumer the constant pressure at which they propose to supply him with energy, and the variation from the pressure so declared must not exceed 4 per cent. under a penalty not exceeding £5 for each default, and a daily penalty not exceeding £5 so long as the default continues. If the regulations are not complied with, it is open to the consumer to proceed against the company for penalties.

Mr. R. CHAMBERLAIN asked whether the right hon. gentleman's attention had been called to the fact that the variation mentioned was taken advantage of in order to supply the consumers, not with an average of 100 volts, but of 97, in that way taking advantage of the concession of the Board of Trade.

Sir M. HICKS-BEACH: However that may be, if the company are in default, the consumers have their remedy. It is not for the Board of Trade to enforce the law.

Mr. R. CHAMBERLAIN: I understand from the right hon. gentleman that we have no remedy unless they get below 96, the 4 per cent. referred to in the answer just given.

Sir M. HICKS-BEACH: Yes, sir, that is so.

**Lighting of Friedek.**—The streets of this small town in Eastern Silesia were lighted electrically for the first time on the 12th ult.

## NOTES.

**The Paris-London Telephone Line.**—It is announced that the cable will start from the French coast near Calais and terminate at Dover, from which town the line will be carried overhead to London. The apparatus in Paris will be provisionally installed at the Bourse, and will subsequently be erected permanently in the Hotel des Telephones in the Rue Gutenberg as soon as that building is completed. The telephone will be available for use both day and night, including Sunday, notwithstanding, as a French paper says, "the rigorous English custom which desires all work to repose on that day." It is believed that the charge for conversation will not be less than 20 francs for five minutes. If all goes well, the line is to be opened on the 15th of February.

**Count Mattei's Coloured Electricities.**—A friend writes:—"Referring to the remarks in your journal of 28th ult. on Count Mattei's remedies, you are wrong in thinking that the Count attributes any of his undoubted success to electricity. He certainly calls his system "Electro-homœopathy," but merely because many of them are quick in action as compared with homœopathy proper, but has nothing whatever to do with actual electricity. I think it is a pity to condemn a system which possibly may have some merit—merely on an erroneous idea."

**Portsmouth New Town Hall.**—The Portsmouth New Town Hall, which has cost £140,000, has an installation of the electric light, and the illumination of the large hall, in which Madame Patti sang on her recent visit to the town, has given great satisfaction. In order to provide efficiently for charging the accumulators with electricity, the Town Hall Committee have been advised that another dynamo should be erected. The tender for this dynamo was £260, but as there will be some other work connected with it, the Town Council at a meeting last week authorised the committee to expend a sum not exceeding £300.

**Lacombe and Company.**—Mr. Holland Dell announces that in consequence of increase of business, Messrs. Lacombe & Co. have taken ground-floor premises at 7, Carteret Street, Westminster, where a sufficient stock will be kept of carbon goods to meet pressing demands at short notice. Attention is drawn to the fact that Messrs. Lacombe & Co.'s works have been enlarged, and the plant increased.

**Glasgow Telephone.**—The new directory of Glasgow subscribers to the National Telephone Company is just published, and contains a notice that on and after the 1st January next the existing rate of £15 per annum for the first connection to the exchange, within the half mile radius, will be reduced to £10. Subscribers private houses, if within a radius of one mile from the nearest switch room, are connected for an annual charge of £8 10s.

**Engineers' Pocket Books.**—We have received copies of the following publications for 1891.—"The Practical Engineer Pocket Book," published by the Technical Publishing Company, Manchester; and "The Mechanical World Pocket Book," published by Messrs. Emmott and Co., of Manchester and London. Both contain a number of tables and items of information the greatest service to engineers, mechanics, draughtsmen, and others.

**The National Telephone Company and Mr. Erskine Muirhead.**—We have received some further letters from Mr. Muirhead, but as they do not contain matter of interest we must decline to print them, and must close the correspondence, which reveals a state of affairs, on the one hand decidedly high-handed, and on the other decidedly deficient in dignity of tone.

**Photography.**—According to the *Amateur Photographer*, Sir David Salomons, Bart., takes a great interest in photography, especially in connection with the Tunbridge Wells Amateur Photographic Association.

**Telephony between Germany and Switzerland.**—Political difficulties have hitherto prevented the establishment of telephonic communication between the towns on the Swiss-German frontier. These obstacles have now been removed, and telephonic lines will shortly be erected.

**High Pressure Alternating Mains.**—*Industries* says: "Reports have of late been freely circulated that the Deptford electric light mains show a very much higher pressure at the London than at the Deptford end. Several eminent scientific men are said to be investigating this phenomenon. We should like to know more about this apparently impossible effect. We may mention another fact, which may be foretold on theoretical grounds, and which, while being apparently similar, is really quite different from that referred to above. For example, if a dynamo is excited to give, say, 5,000 volts at the terminals before the mains are connected, it will give considerably more directly they are thrown on, especially if the load is very light, but the increased pressure will be at Deptford as well as in London. The rise of pressure can be roughly calculated beforehand if the particulars of the dynamo and mains are given. A higher pressure in London than Deptford at a given time appears quite incapable of explanation with our present knowledge."

**Tapping Holes in Porcelain with Fine Threads.**—Messrs. Taylor, Tunnicliff & Co. send us the following note:—"Messrs. Bullers appear to have misconstrued the remarks on the above question in your issue of November 14th. It is well known that coarse threads in porcelain have for a considerable time been made in large quantities by the various firms engaged in the trade; but the finer pitch of Whitworth threads of  $\frac{1}{16}$ th to  $\frac{3}{8}$ th diameter are but of very recent introduction, and present considerable difficulty in production in the stereotyped methods, as well as uncertainty in the finished articles. All we claim is that we have invented a machine which ensures a solid thread of fine pitch and regularity of size, much superior to the ordinary hand-made article. We do not think Messrs. Buller will deny that this requirement is of but recent introduction, and has not been in use the number of years their remarks would have you to suppose."

**Electropathic Belts.**—It is surprising to find papers, edited by men who have graduated at Oxford or Cambridge, allowing their columns to be prostituted by the advertisements of so-called medical electricians. The *Whirlwind*, the organ of the Hon. Stuart Erskine and Mr. H. Vivian, contained on the 22nd ult. what, at first sight, appeared to be an article referring to the Rev. E. F. Shaw. The eighth line, however, showed conclusively that the article, which was prominently given on the front page of that paper, was only an advertisement of the "Eminent's" electropathic belts. The editors of the *Whirlwind* cannot be congratulated on the results of their schooling.

#### Recent Interruptions and Repairs to Submarine Cables and Land Lines, up to 25th November, 1890:—

Cables.	Interrupted.	Repaired.
Suakim—Perim ...	12th Sept. ...	Still interrupted.
Cape St. Jacques—Thuanan	21st Oct. ...	27th Oct.
Porthecurno—Vigo ...	1st Nov. ...	20th Nov.
Vigo—Lisbon... ..	1st Nov. ...	17th Nov.
Mozambique—Louvenço-Marquez ...	11th Nov. ...	11th Nov.
Mozambique—Louvenço-Marquez ...	18th Nov. ...	19th Nov.
Trinidad—Demerara ...	18th Nov. ...	Still interrupted.
Salina Cruz—Libertad ...	25th Nov. ...	" "
Land-lines.		
Moulmein—Bangkok ...	22nd Oct. ...	24th Oct.
" " " ...	9th Nov. ...	10th Nov.
Dakar—Yof ...	27th Oct. ...	29th Oct.

**The Electrode.**—Mr. D. Hillock, of 58, Berners Street, W., believes he has made an important discovery. He advertises "The Electrode," by the use of which "the blind recover their sight, the deaf their hearing, and those who have lost their voice regain it." Electricians do not see, neither do they wish to hear, but they raise their voices to protest against the use of such bogus statements.

**The City Lighting.**—Why the City papers and others grumble about the delay in the electric lighting of the City cannot be imagined. A man or a company is not likely to complete a contract before the close of the stipulated period without receiving some pecuniary benefit; and yet people talk about the "knowing City men."

**Reduced to the Ranks.**—Mr. J. Swinburne has lost his German "professorship," which he only recently gained. The *Elektrotechnische Zeitschrift* has been pleased "to undress" the (word) "professor."

**Fire Brigade Failings.**—A representative of *Trade, Finance, and Recreation* has had an interview with Captain Arthur Shean on "Fire Brigade Failings." We are acquainted with Captain Shaw and with Mr. Simmonds, his second in command, but we scarcely think that the author of the following remarks can be attached to the London Fire Brigade; if so, he might with advantage take a course of lessons on elementary electrotechnics at one of the technical colleges:—Q. "Have the fire brigade any special method of dealing with fires caused by the imperfect insulation of the electric light?" A. "No, they have neither received any instructions with reference to the matter, nor been provided with proper implements. A man ought not to cut an electric wire with an ordinary hatchet unless he wears an India-rubber glove, and yet such a glove does not exist in the whole brigade. I was at a theatre the other night which is lighted with electricity, and I asked the fireman what he would do if the electric light were to ignite any part of the building? I was astonished to find that he knew nothing about it, and that there was nothing in the theatre in readiness for such a calamity. One of these days we shall have a great sensation, because a fire caused by electricity is more serious than an ordinary fire, since you have the ignitable force fitted all over the building. Up to the present there have been several accidents in London through electric lighting, and surely we ought not to wait till some great disaster occurs before attending to the subject." What does the gallant Captain mean by the ignitable force being fitted all over the building? Is not gas fitted all over a building, and when a rupture occurs in an electric conductor does not the ignitable force vanish at once?

**Guaranteed Accumulator Maintenance.**—The General Electric Power and Traction Company, Limited, is now offering to tramway companies to supply cars and the electrical equipment, and to maintain the motors, switches, gearing, and accumulators at a mileage rate; the tramway company operating the road at their own expense. The result of the experience at Barking enables this company to undertake electric plant maintenance at such a price that, including the cost of generating the power, &c., traction by accumulator cars will be less costly than that of horses; and in northern towns, where coal is cheap, the cost will be much below that of horse traction. A recent improvement in the "E.P.S." accumulators warrants the statement that this form of traction on average roads must of necessity be in all cases less than that of horse traction. The company is at present in negotiation with some of the largest tramway companies in the country on these lines. The company is also busily employed in the manufacture and erection of mining plant for many of the principal collieries in the country. This branch of the work is rapidly developing.

**Tramway Companies and Electric Traction.**—The North Metropolitan Tramway Company has received the consent of the London County Council to run electric cars over the northern portion of its line, controlled by the Council, during the term of 7 years. The tramway company has also given notice of a Bill which it intends to introduce into Parliament, asking Parliament to compel the local authorities to conform to the Act as passed last session, giving the tramway company the full term of seven years guaranteed by the Act. At present, the West Ham local authorities decline to grant more than one year's license, subject to 24 hours' notice. It is, hoped, however, that they will now follow the example of the London County Council, and grant the full term of the license, enabling the tramway company to equip two roads on which their lines run, and which are in the parish of West Ham, and on which it is the intention of the tramway company to place electric accumulator cars.

**Automatic Fire Alarms.**—On Wednesday, December 3rd, there took place in the arsenal of the Great Lake, Genoa, in presence of the territorial director and vice-director of artillery and of various officers of the artillery and the military engineers, the first experiments on the auto-electric fire alarm and signal thermometer on the Bieberstein-Fois system, which the inventors offer in homage to the king. The experiments succeeded surprisingly: the apparatus combined the sensitiveness of the mercurial thermometer and gave instantaneous alarms at whatever temperature, which result is due in part to the excellent workmanship of the establishment for instruments of precision, A. E. Conti (Sant Algo, Genoa), which may compete for such kind of work with the first foreign houses.

**Ironmongers and Sale of Electrical Fittings.**—Our contemporary *Ironmongery*, "to give further effect to oft-repeated counsel that ironmongers should take up electrical fittings as a substantial branch of the trade," purpose commencing in the January number a series of practical articles on electric installations, for the guidance of those who intend taking up the sale of electrical accessories.

**The London Electric Supply Corporation.**—We understand that Mr. Ferranti has shut off the supply of electrical energy to the customers of this corporation, and that it may be two or three weeks before the current will be turned on again. We believe that the mishap, to which we refer in our leading pages, is mainly the cause of this temporary stoppage. With the apparatus once again in working order, Mr. Ferranti does not intend to allow a recurrence of the recent disaster.

**Underground Cables.**—We have received two important communications bearing upon the letter in our last issue, "Notes on Electric Lighting from Central Stations." The first is from Mr. Alfred E. Mavor, general manager to the Fowler-Waring Cables Company, and the second is penned by Mr. Ferranti, and both give direct denials to the statements contained in the copy of the India Rubber and Gutta-Percha Company's letter. We shall publish these in our next issue.

**A Correction.**—In our note on Theatre Lighting last week we should have stated that Messrs. C. E. G. Gilbert & Co. had secured the contract for lighting the Globe Theatre, the name of Messrs. Dickinson being an error.

**Montevidean and Brazilian Telegraph.**—An extraordinary general meeting of the Montevidean and Brazilian Telegraph Company, Limited, was held on Wednesday at Langthorn House, Copthall Avenue, Dr. Cameron, M.P., presiding, when resolutions passed at an extraordinary general meeting held on November 25th, and reported in our issue of November 28th, were confirmed.

**Popularising the Telephone.**—The *City Press* says: "With the New Year it is understood that the Post Office authorities will make new arrangements for the public use of the telephone, tending to popularise the instrument and bring it into general employ." We understand that no important step will now be made by the authorities, at least until after the transmitter patent of Edison expires next July.

**Marriage of Captain Khotinsky.**—The marriage of Captain A. de Khotinsky, of Rotterdam, the inventor of the Khotinsky electric system, with Mrs. M. Fuller, widow of the late P. Fuller, Esq., of Blackheath, Kent, was celebrated in London on the 24th ult. We learn that Captain de Khotinsky and his bride sailed, per ss. *Teutonic*, for a tour in the United States, where he intends to establish a lamp factory at Boston for the manufacture of the Khotinsky lamp and other appliances used in connection with his system.

**The New West India Cables.**—The new cable laid by the *Westmeath* for the Société Française du Télégraphes Sousmarin's between Port de France, Martinique, and Paramaribo, Dutch Guiana, was opened on the 9th December for international traffic. The provisional tariff established by the Société Française des Télégraphes Sousmarins is an addition of 2.20 francs per word to the existing rates to Martinique. The Anglo-American Company notifies that in consequence of certain misunderstandings which have arisen with respect to telegrams sent by post from Mole-St. Nicolas to Port-au-Prince, and from Colon to Barranquilla, it is necessary to remind the public that these telegrams carry, in addition to the tariff, a postal tax of 1.25 francs.

**University College, Aberystwyth.**—The workshop accommodation of the physical laboratory in the University College of Wales, Aberystwyth, has recently been considerably extended, and arrangements are being made for a course of instruction in electrical engineering. The recent additions include a high speed gas engine, specially adapted for electric lighting, a Crompton dynamo (shunt and compound wound), and a Crompton D.D. arc lamp, &c.

**Extension of Telephony in South Wales.**—The South Wales Telephone Company have opened communication with Port Talbot.

**Improving Insulation.**—Perhaps some of our readers may know whether the electrolytic method of improving insulation, described in our correspondence columns by Mr. A. A. Campbell Swinton, has ever been previously adopted.

**American Company Dividends.**—The New York Edison Electric Illuminating Company has declared a quarterly dividend of 1 per cent., payable January 15th, with an extra 5 per cent. in scrip, convertible upon an increase in the capital stock, and bearing the same interest as the present stock; Bell Telephone, 3 per cent., all payable January 15th.

**Electric Lighting at Bognor.**—At a meeting of the Local Board, last week, a letter was read from the secretary of the Electric Trust, Limited, stating that the company were prepared to enter into negotiations with a view to undertaking the public lighting of Bognor by electricity. They would be prepared to supply a 16-C.P. lamp for £4 per annum, and enter into a three years' agreement. The system would be similar to that adopted at Woking, and the company invite the board to visit the works at that place, when their system of working would be fully explained. The matter was eventually referred to a special committee.

**Electric Lighting Fatality.**—Yet another victim is added to the long list of fatal accidents due to electric lighting currents. At Chicago, on the 2nd December, a linesman was instantaneously killed from coming in contact with an electric light wire. Details of the mishap are not yet to hand. So long as bare wires are employed, or indifferent insulation made use of, undertakers may rely on electric lighting for some addition to their business.

**Cable Subsidy.**—In a paper read before the Royal Colonial Institute on November 11th, Mr. George S. Mackenzie stated that the German Government had granted to the Eastern and South African Telegraph Company an annual subsidy of £5,000 for the cable which this company has just laid between the Island of Zanzibar and Bagamoyo, the capital of the German Protectorate on the East African Coast.

**Good News for Wine Bibbers.**—A new cure for gout has, according to the *Matin* of Paris, been discovered by Mr. Edison, the American electrician. It is stated to consist in the simultaneous use of lithine and electricity.

**City and South London Railway.**—It is rumoured that this railway will be opened on Monday for public traffic.

#### NEW COMPANIES REGISTERED.

**Marine and General Automatic Company, Limited.**—Capital £20,040 divided into 4,000 ordinary shares of £5 each and 40 founders' shares of £1 each. Objects: To purchase from W. T. Wright Thackeray, Isaac Hurn and John Davies, the patent rights of improvements in automatic electrical tell-tale apparatus, with power to purchase other inventions relating to marine and other engines. Signatories (with one ordinary share each): J. Davies, East Sheen; G. J. Bridges, Chepstow Rise, Croydon; S. Bradford, Kingston-on-Thames; Isaac Carr, Walthamstow; T. E. Colcote, 5, Lancaster Place, Strand; \*Lieut. St. John, R.N., 119, Confield Gardens, West Hampstead; H. C. Bridges, 20, Hart Street, W.C. The first directors are Lieut.-Colonel F. Despard, Anthony McKeand, Lieut. St. John, and Thomas Wilkins, C.E. Remuneration—chairman £3 3s., and each director £2 2s., for every meeting attended. Registered 29th ult. by Andrew Wood & Co., 8, Gt. James Street.

**Plenty & Son, Limited.**—Capital £25,000 in £10 shares. Objects: To take over the business of marine, general and mechanical engineers, carried on by Plenty & Son, at the Eagle Iron Works, Newbury, Berks. To carry on the business of electricians and as manufacturers and dealers in apparatus and things required for the generation, distribution, supply, accumulation and employment of electricity. Signatories (with one share each): \*E. P. Plenty; E. P. Plenty, Jun.; John Mason, Newbury, Berks; Laurence Read, 18, Hanover Street, W.; J. Clarke, Chieveley, Berks; \*Earl Russell (electrical engineer), Amberley Cottage, Maidenhead; \*H. Wethered, Clifton, Bristol. The signatories denoted by an asterisk are the first directors. Qualification 50 shares; the company in general meeting will appoint remuneration. Registered 29th ult. by R. Jordan, 120, Chancery Lane.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**"Electrician" Printing and Publishing Company, Limited.**—The annual return of this company, made up to the 28th October, was filed on the 3rd inst. The nominal capital is £10,000 in £10 shares; 940 shares are taken up, 800 of which are considered as fully paid. Upon 140 shares the full amount has been called and paid.

**Woodhouse and Rawson Electric Construction and Maintenance Company (Lancashire, Yorkshire and Cheshire), Limited.**—The final winding up meeting of this company was held on the 25th ult., when an account was given, showing the manner in which the winding up has been conducted and the property of the company disposed of. The notice was filed on the 4th inst.

**Electric Tramways, Construction and Maintenance Company, Limited.**—The annual return of this company, made up to the 2nd July, was filed on the 3rd inst. The nominal capital is £250,000 in £1 shares, but although the company has been in existence since the 8th December, 1886, only seven shares have been taken up, and upon these no call has been made or paid.

**Electric Wiring and Fittings Company, Limited.**—An agreement of 24th ult., filed on the 5th inst., between Latimer Clark, Muirhead & Co., Limited, and this company, provides for the cancellation of 1,500 fully paid shares allotted to the former under an agreement of 22nd November, 1889.

**Atlas Engine Company, Limited** (engineers, contractors and electricians).—The statutory return of this company is made up to the 2nd September. The nominal capital is £12,000, in £1 shares, but only seven are at present taken up, and upon these the full amount has been called and paid. Registered office, Poole, Dorset.

**Gordon Electric Traction Syndicate, Limited.**—An agreement of 18th August between John Gordon, of 13, Nettleton Road, New Cross, electrical engineer, provides for the purchase from him by the company of a system of electric street car traction, provisionally protected on the 5th May, No. 6,083. The purchase consideration is £600 in fully paid £10 shares. Mr. Gordon is appointed managing director for two years, at a salary of £4 per week.

**Sheffield Telephone Exchange and Electric Light Company, Limited.**—An agreement of 9th September (filed 6th October) provides for the taking over, by this company, of the business carried on there by the company in liquidation of the same title. The new company will discharge the debts and liabilities of the old company, and shall adopt and perform all its contracts and engagements now binding. Every shareholder other than Mr. John Tasker will be entitled to one new share, credited with £8 as paid up in respect of each £10 share in the old company, and the said Mr. J. Tasker, in respect of each of 3,077 shares, with £8 paid up, shall have allotted to him, or his nominees, one share in the new company, credited with £8 paid up; and he undertakes to make no claim in respect of 2,000 fully paid shares held by him.

**Plymouth and District Pulsion Telephone.**—The statutory return of this company, made up to the 25th ult., was filed 29th ult. The nominal capital is £4,600, in £1 shares. 4,150 shares are taken up, upon 3,100 of which 1s. per share has been called, and upon £1,050, 3s. per share. The calls paid amount to £3,257 10s.

**Woking Electric Supply Company, Limited.**—The annual return of this company, made up to the 19th ult., was filed 24th ult. The nominal capital is £20,000 in £5 shares. 2,067 shares are taken up, 2,000 of which are considered fully paid. Upon 60 shares 5s. per share has been called, and upon seven shares £1 5s. has been called, the calls paid amounting to £23 15s.

**Nonpariel Electric Syndicate, Limited.**—An agreement of 21st ult. (filed 27th ult.) with J. Tarbottom Armstrong, of 8, Suffolk Lane, and J. Mason, of 28, Cardigan Road, Bow (the vendors), provides for the purchase by the company of the letters patent No. 1,757, dated 12th October, 1880, relating to an improved automatic coin-freed apparatus for imparting electric shocks, together with the machines and appliances belonging to the vendors. The consideration is £4,000, half in cash and half in fully-paid shares.

## CITY NOTES, REPORTS, MEETINGS, &amp;c.

**Fowler-Waring Cables.**—Meetings of electrical companies have been prolific during the past few days. Fowler-Waring Cables shareholders dropped in to their annual meeting to ascertain the date of probable dividends. The chairman met them with statements of delays (not specified), which were now overcome. A good factory had been secured, an able manager was running it, and the directors expected that from that day there would be nothing but plain sailing. It is a remarkable fact that the position of a company looks brighter and sounder on the day of the annual meeting than at any other subsequent or previous period. Shareholders were invited to view samples of work at the London office, and the machinery at the works. If this were done, it was said, they would recognise the sound basis on which the company rested. It is to be hoped, and we believe, that there is a sounder foundation than samples and machines. In the course of the meeting it was remarked that the board of directors, which is certainly a large one, ought to be reduced. It is said that one member, Colonel North, is so impressed with the capabilities of his colleagues that he has not deemed it necessary to put in an appearance at any single board meeting this year.

**The Electric Construction Corporation.**—This corporation held its first annual meeting on Monday. The chairman (Sir H. Mance) remarked that the company possessed patents of undoubted value, which, although undeveloped, would, in the hands of subsidiary companies, now formed, prove a solid source of income. Upon paper their transactions looked very flourishing indeed, but he hoped shareholders would support the policy of the directorate in the decision not to apply any profits of the sales of patents to the credit account until the patents had been written off. They were carrying on, at Wolverhampton and Millwall, continuous experiments. A notable one was the extraction of phosphorus by means of electricity. In view of the progress of electric lighting in England, and probable contracts, was decided, in order to secure increased business, to make an issue of £100,000 of debentures bearing six per cent.

**Reuter's Telegram Company as an Advertising Concern.**—Reuter's Telegram Company is taking advantage of that clause of articles of association which enables any commercial undertaking to make money out of business, as widely different as the supply of public electric lighting and the washing of private linen. It is intended to take up an international advertising agency by means of their cables.

**The National Telephone Company; another Magna Charta.**—The National Telephone Company will pay, in a few days, a dividend of 5 per cent., which is the last before the expiry of the patents held by it and its predecessor with peculiar injudiciousness for a good many years. During this period, their bearing towards customers has slowly, if silently, created a host of enemies, whose ill feeling and bitterness may have great influence on future developments of this concern. The company's position is analogous to that of King John, and the charter of liberty for the users of the telephone may be said to date from July of 1891.

**The Gülcher (New) Electric Light and Power Company, Limited.**—The report of this company and balance-sheet to June 30th, 1890—nearly six months after date—are to hand. An important feature mentioned in the report is that the 10 per cent. debentures, of which class only £400 at present remains unredeemed, has been paid off. We notice that a detailed profit and loss account will be submitted to the shareholders at the general meeting. As the balance from this account (£201 17s. 7d.) is given in the balance-sheet, it is difficult to see why so long a period should elapse before the detailed statement is ready. The directors state that the heavy interest payable on the second mortgage debentures has alone prevented the payment of a dividend, and now that these are practically cleared off, we hope that this year's account will prove even much more satisfactory than the last.

**The Fowler-Waring Cables Company, Limited.**

THE first annual report of the Fowler-Waring Cables Company was presented to the shareholders on Friday last. At the time of the statutory meeting they hoped that the buildings and

machinery would be completed in spring or early summer, but there were so many unexpected delays, that only within a recent period has it been possible to execute orders at North Woolwich. The directors regret that in consequence of these delays they are unable to present a favourable balance-sheet, but they are glad to be able to state that the work is now proceeding well, and they look forward with confidence to the future.

A transfer of the work from Leeds has been effected, and a portion of the plant has been taken over, in accordance with the agreements made with Messrs. John Fowler and Company (Leeds), Limited.

The following is the general manager's report:—Since assuming the management of the company in the beginning of July, I have been mainly occupied with the organisation and equipment of the factory, which is now on a thoroughly good working basis. Many of the machines, which are of a particularly light construction, were, unfortunately, damaged in transport from America, and the repairs and renewals have been somewhat tedious, and have necessarily involved considerable delay. They are now, however, in operation, they are highly efficient machines, and it is doubtful if their working capacity is rivalled in this country.

In the selection of suitable foremen for the various departments, I have been specially fortunate in securing the services of a number of men of long experience in cable manufacture, and the quality of the work now produced is most favourably commented upon by all who have used or seen our cables. Although the orders completed up to date do not represent a very large sum, they are still significant as opening business in all the important branches of electrical engineering, and in no case is there a failure recorded against our company.

In telephony, we have manufactured a number of important cables for the National Company, and one composed of 50 wires is now being laid in the tunnels of the Metropolitan Railway. In cost and efficiency, I believe we can easily distance all our rivals in telephone cables, and there must be an immense development in the immediate future of underground telephone systems.

In telegraphy, we have had opening orders from several of the leading railway companies, and our prospects with the Post Office Telegraph Department are exceedingly good. We have also fulfilled trial orders for several of the Colonial Telegraph Departments, and our reports from them foreshadow future business.

The branch of electrical engineering which is at present commanding most attention is the transmission of power, and it is satisfactory that only our cables are employed in the new City and South London Subway, which is the first electric railway in this country.

In electric lighting, we have a constantly-increasing business, but it is here we meet with the keenest competition. The use of lead-covered cables will greatly extend when their value becomes more widely known. Rubber covered wires, however, are often specified to the exclusion of all others, and we think it advisable to meet the large demand for these conductors, and my arrangements for the manufacture of these are almost complete. It is our intention to manufacture all classes of electrical conductors, and we are also prepared to contract for carrying out electrical operations of every description.

Every year marks a steady advance in the progress of the electrical industries, and I am confident that we shall have an important share in the developments of the future. Our factory is splendidly situated, and admirably adapted to our requirements.

At the meeting the Chairman (Mr. W. Fowler) said that when he had met the shareholders a year ago he had certainly anticipated that they would make further progress during that period than had proved to be the case; but they had met with unexpected delay, and were consequently not so forward as they had hoped to be. He was glad to tell them, however, that they had now a factory in most excellent order, and would be able to do a large and profitable business in future. They had, too, and had had for some months past, a most excellent manager, who resided in the factory, and was consequently able to exercise a continued supervision. He would like any shareholder who felt any doubt about the company to go down and look over the factory; he thought he would agree that the position was a good one, the machinery excellent, and the work of the most superior quality. As to the quality of the work, an inspection of the samples to be seen at their offices in Queen Street would satisfy anyone that it was of the most excellent character. With regard to the condition of the company's business, the report—combining as it did both the managers' and directors'—stated that so clearly, that it was needless for him to add to it. He would say, however, that as the directors had made no profits for the shareholders (perhaps they ought not to have expected any the first year) they had taken no fees, although they had done a great deal of hard work, and had had a great deal to think about.

The report was seconded and carried *nem. con.*

On the motion to re-appoint the auditors, a shareholder objected to the amount of fees (50 guineas per annum) which they received, and it was finally resolved that though they should be re-appointed, that the directors should confer with them and endeavour to obtain a reduction.

The same shareholder thought that seven directors were too many for so small a company. It would be most invidious for him to single out any individual, but he hoped that the board would themselves consider this matter, and that when next the company was assembled there would be a smaller directorate.

The usual vote of thanks concluded the meeting.

### The Electric Construction Corporation.

THE first ordinary general meeting of this corporation was held at Worcester House last Monday.

The Secretary read the notice convening the meeting, and also the auditors' report.

The Chairman (Sir Henry C. Mance), in going through the accounts, said that the £4,061 on account of apportionment of profit between the vendor and the corporation, which appeared on the credit side of the profit and loss account, represented the amount which, after liberal deductions for depreciation, cost of experiments, &c., the auditors certified as profits belonging to capital, and that, although they had taken over the benefit of the work of the company from September, 1888, they were not allowed to account as revenue any profits made before the date of the incorporation of the company, but they would understand that though they had not these earnings set out as profits, they had them in the increased value of the business. The items works, sales, and expenses spoke for themselves, and he had only one remark to offer—that, in working out the rate of profit, they should deduct a considerable part of the £14,000 charged as head office expenses, for these expenses covered a period of nearly 16 months—not merely 12. In connection with the interest upon temporary loans, it had been necessary to obtain temporary advances from their bankers in order to complete the agreement with the vendors. Part of it might have been charged to capital, but the directors had thought the placing of the affairs of the company upon a sound financial basis was of more importance than the presenting a more favourable balance-sheet. Speaking of the expenses they had been put to for advertising, the chairman said they would easily understand that advertising must always be a serious cost. Considerable expense, too, had been incurred for goods sent to the Edinburgh Exhibition, which was practically another form of advertising, and in pursuance of a policy of being always on the safe side, and of remembering that returned goods were often much depreciated in value, they had written the expense entirely off their books, so that if anything came into the funds from it it would be all profit. When the corporation had taken over the business there had been foreign patents of undoubted but of undeveloped value. The patent fees themselves were a heavy charge, whilst the income was nominal. The directors had realised these foreign patents by handing them over to subsidiary companies and accepting payment in shares. Experiments were constantly being made at their works at Wolverhampton and Millwall, and the chairman anticipated that before very long they would be possessed of a means of obtaining phosphorus by means of electricity. It might be in the minds of some of the shareholders that the aluminium process had been entirely revolutionised by the application of electricity, and he saw no reason why it should not be so with phosphorus. Turning to the balance sheet, he regretted that calls in arrear should form so large an item, but they had been passing through a very difficult and trying time in the City, and many gentlemen had had great difficulty in meeting the calls made upon them. Liabilities to trade accounts included a substantial sum in reserve, which they were not likely to be called upon to use, and the liabilities to capital account were almost paid off, though there were still considerable liabilities for the Bushbury works, and other matters, in course of settlement. Their contract for the equipment of Rathbone Place and Manchester Square stations was now almost complete, though there was a responsibility for the running of the machinery which would not disappear for some time to come. With regard to contingent liabilities for calls made by the subsidiary companies, there was not much likelihood of their becoming actual liabilities, except in case of such a development of the business of these subsidiary companies as would be a matter of congratulation to themselves. Turning to the credit side, the purchase money, £397,300, had been reduced by stock, book debts, &c. This was merely a matter of book-keeping, for the items appeared lower down; but the further reduction of £100,000 for licenses and sales was not a matter of book-keeping, a fact on which they might congratulate themselves. Their capital expenditure since the acquisition of the business had been practically limited to the laying out of the new Bushbury works, the cost of which had been greater than was originally contemplated; but they had felt themselves bound to be liberal in this direction for the sake of the increased facility in turning out work, for while they warmly desired to make profits out of the subsidiary companies, they must look for future dividends to their manufacturing profits, and their business was to put their company into the foremost rank, as they had endeavoured to do. While on this subject, it was not enough to have a reputation for turning out good work—that they had—they must have a reputation for turning it out with despatch. During the past year they had been obliged to refuse orders because they could not guarantee delivery within the time appointed; but now they had a factory at their disposal, which would enable them to meet all the requirements likely to be made in the future, as the shareholders would agree if they would go down and see it for themselves. Looking at the numerous applications made all over the country for provisional orders, and the progress already made by the different supply companies, they could have no doubt for the future of the electric light; but great as was this field, he thought it likely to be eclipsed by the demand made for electricity for other purposes. In America, the motor industry was greater than the lighting industry. In this matter they were not only better, they were cheaper than any of their rivals. If any of the share-

holders should visit their works at Bushbury they would find how thoroughly the directors believed in the future transmission of power by electricity for all the machinery there was worked by power communicated electrically. They had been disappointed in the matter of train lighting, and gentlemen who owned shares in railways were urged to bring pressure to bear upon their directors, but they had been more fortunate with electric traction, for a series of electric tramcars had been established at Birmingham, where they were now working in a very satisfactory manner, and this he hoped was only the first of a long series of installations to be made all over the country. Seeing these installations coming, and having regard to the necessary expenditure on new works, he thought the time had now come to ask for more capital. They proposed to issue the sum of £150,000, in 6 per cent. debentures. They had postponed this as long as possible, but they thought now they would be neglecting the interests of their shareholders if they did not make the issue at the very latest early next year. They hoped these debentures would be mainly taken up by the shareholders, while as for the directors they were quite willing to take up more than their share. There would, however, be a public issue in order to get a quotation on the Stock Exchange.

Some shareholders having spoken criticising the action of the directors in selling so large a part of their business to subsidiary companies, as turning into a company promoting what should be a manufacturing concern, and one of them having asked whether this had anything to do with the retirement of Sir Douglas Fox,

Mr. J. Spencer Balfour stated in reply that there was no reason whatever for the retirement of Sir Douglas Fox except the one he himself assigned, namely, that he had not time to attend to the affairs of the company. As to the policy of the board in selling their business to subsidiary companies, it was the wisest course to adopt, because it enabled them to give their attention to manufacturing, which would otherwise be neglected. As to the rate of interest—6 per cent.—which was proposed to be paid upon debentures, this was the usual rate, but the debentures could easily be issued at 5 per cent. if the shareholders in the corporation would take them at that rate.

The adoption of the report having been moved, seconded and carried, the question of the reappointment of the retiring directors came up for discussion. Sir Daniel Cooper, with Messrs. Balfour, Courtenay and Dibley were reappointed, and Mr. Mander proposed that Mr. Thomas Parker, the managing director of the company, take the place of Sir Douglas Fox, resigned. This was opposed by Sir Daniel Cooper and some shareholders on the ground that a seat at the board would be incompatible with his present position as servant of the corporation, and the motion was finally withdrawn.

The auditors were then re-elected, and a vote of thanks to the chairman and board concluded the meeting.

### Reuter's Telegram Company, Limited.

ON Saturday last, at 12, a special general meeting of the company was held at their offices in Old Jewry. The secretary read the notice convening the meeting, and two resolutions, the first, that the company's capital be increased to £100,000; and the second, altering the provisions of the memorandum of association and giving the company power to carry on the business of advertisement contractors and agents.

The Chairman (Sir J. C. D. Hay) remarked that the two resolutions were interdependent upon one another, and that unless both were carried the other one would be inoperative. Proceeding, he said that: Before moving the adoption of the resolutions, he would explain the objects in view in asking an extension of the powers of the company and an increase of capital. They must not suppose that the present capital was insufficient for the existing business. True, they had to incur considerable expense in keeping abreast with the growing demands for telegraphic intelligence, but at present their capital was adequate, so far as it was necessary to provide agents and correspondents with funds; and though it might be found advisable in the interests of their subscribers to supplement existing services with special accounts of remarkable events, trials, fires, &c., on a larger scale than had been hitherto considered necessary, yet these would be the subject of further consideration in conjunction with the newspapers themselves, and would, no doubt, be met by the contributions which would recoup the outlay. The primary object of the proposed alteration in their memorandum of association, and the increase of their capital, was to enable them to undertake the business of collecting advertisements for the newspapers, who were their supporters. Their organisation was particularly adapted for this class of business, and the idea had been long entertained by their managing director, who had not failed to notice the great expansion of advertising of late years. The law had until recently regarded a memorandum of association as unalterable; but during last session an Act was passed empowering companies, under the sanction of the High Court, to enlarge the sphere of their operations, of which power they proposed to avail themselves. It was obvious that with agencies in all the capitals of the world who were brought into direct communication with the newspapers, that the company had exceptional means of establishing an international advertising business on a large scale, with immense advantage to their subscribers. Some apprehension had been expressed in certain quarters that the working of the advertisement business might

prove detrimental to the telegraphic services, inasmuch as the latter had to deal with financial affairs, and many things that advertisers might influence; but he would point to their reputation, and ask if it were likely that the directors would commit the suicidal folly of allowing any advertiser to influence the impartiality which had characterised their service since its creation. As a safeguard, however, it was proposed to keep the telegrams strictly apart from the advertising branch, which would be managed by a separate staff in separate offices. They were sanguine that the new business would be found a good source of revenue, but shareholders must not look for increased dividends at the commencement. The organisation of an international business took time, and could only be accomplished after much negotiation; but they had taken preliminary steps abroad in conjunction with the largest advertising agency on the continent, and as soon as the shareholders' consent was obtained, and the sanction of the High Court obtained, they would be ready to start the new machinery. In addition to advertisement business, they believed it might be found profitable to undertake telephonic and other services, and to extend their business in many directions, now barred by their restricted memorandum of association.

The Chairman then put the resolutions, which were seconded by Baron de Reuter, and carried *nem. con.* Another meeting will be held, in accordance with the Act, on the 23rd, to confirm them.

The Ward Electrical Car Company, Limited.

The first annual general meeting of this company took place at the depot, 12, Dacre Street, Westminster, on Wednesday, the 3rd December, 1890, Mr. E. R. Cummins in the chair.

The Chairman reported that the details of the contract for the construction of the first line of omnibuses, and for the charging station, had now been finally settled with the Electric Construction Corporation, Limited, and that the work will be at once proceeded with; also that the Board intended, as soon as this line is running, to form a sub-company for London, to take over the station and omnibuses, and to work a large line of vehicles; that the various authorities concerned view with great interest the pending introduction of electrical carriages on the streets of London; and that it is intended to form sub-companies for other places in the U.K. and abroad.

The Managing Director then reported having just received an order for an electrical van for trade purposes from a firm who intend to largely introduce them, and that an important tramway company had practically concluded to place a contract with this company.

The Gülcher (New) Electric Light and Power Company, Limited.

The directors in their report state that they have pleasure in presenting to the shareholders the balance-sheet for the 12 months ending 30th June, 1890.

It will be observed that the preference capital of the company, which on the 30th June, 1889, consisted of 12,277 preference shares, having £12,241 1s. 4d. paid up, consisted on the 30th June, 1890, 50,000 preference shares, having £30,797 8s. paid up.

It will also be seen that the £10 per cent. 2nd debentures, which, on the 30th June, 1889, amounted to £8,862 10s., and which, at the date of the last report, had increased to £16,000, were on the 30th June, 1890, reduced to £400.

This satisfactory alteration of the capital account is mainly due to the response made by a limited number of shareholders to the prospectus issued on the 1st January last, inviting subscriptions for the then unissued preference shares.

The central stations for the public lighting of Wellington, New Zealand, upon which, on the 30th June, 1889, the company had expended £9,598 18s. 8d. were shortly afterwards completed. On the 30th June, 1890, this important installation stood as a debtor in the company's books for £13,486 13s. 3d., since which time the amount has not been increased.

The directors, in their last report, pointed out to the shareholders that the commercial success of this undertaking would depend entirely upon the provision of further capital for private lighting. They concluded, however, after careful consideration, not to lock up so large a portion of the newly-subscribed capital as would be necessary to enable the company exclusively to provide for this private lighting. A well-supported syndicate has accordingly been formed, which will not only provide for the private supply of the town but will ultimately take over this company's business in New Zealand, together with the benefit of the contract for public lighting, entered into between this company and the Mayor and Corporation of Wellington.

The particulars of the contract between the New Zealand Electrical Syndicate and this company, and of other contracts undertaken and carried out during the past year, will be supplied at the general meeting, when a detailed profit and loss account will also be submitted to the shareholders.

In the autumn of last year this company contributed towards the registration of "The South-Western District and Thames Valley Electricity Supply Company, Limited," from which the directors have reason to anticipate good results.

The gross manufacturing profits for the year ending 30th June, 1890, amounted to £3,097 2s. 4d., which, compared with the manu-

facturing loss of £1,417 6s. 6d. in the preceding year, must be regarded with satisfaction.

The heavy interest payable on the second mortgage debentures (nearly all of which, however, have been now paid off), has alone prevented the declaration of a dividend. Since the last general meeting Mr. Binswanger has resigned his seat at the board. The directors, under the powers conferred on them by the articles of association, recently elected Mr. C. S. B. Hilton, a large shareholder, to assist in the direction of the company. Mr. De Castro and Mr. Hilton retire from the board, but, being eligible, offer themselves for re-election.

Mr. Russell Day, the auditor appointed at the last general meeting, also retires, but offers himself for re-election.

THE BALANCE SHEET, JUNE 30TH, 1890.

DR.		£	s.	d.	£	s.	d.
To capital, authorised	...	70,000	0	0			
Issued 20,000 Deferred shares of £1 each, fully paid	...	20,000	0	0			
" 12,277 Preference Shares of £1 each, 20s called up	...	12,277	0	0			
" 37,723 Preference Shares of £1 each, 7s. 6d. called up	...	14,146	2	6			
70,000		£26,423	2	6			
Less unpaid		2,942	5	4			
		£23,480	17	2			
Add calls paid in advance	...	7,316	10	10			
					30,797	8	0
To £6 per cent. First Mortgage Debentures	...				8,000	0	0
" £10 per cent. Second Mortgage Debentures	...	£10,000	0	0			
Less paid off	...	9,600	0	0			
					400	0	0
" Bills payable	...				393	16	7
" Creditors as under:—							
Trade Debts	...	1,561	12	1			
Commissions	...	1,500	0	0			
Interest on Debentures	...	189	7	10			
Rent, Rates and Taxes	...	56	19	3			
Law Costs	...	190	8	4			
Salaries, &c.	...	132	5	1			
Directors' Fees	...	236	15	10			
					3,867	8	5
" National Provincial Bank of England, Limited	...				2,493	7	3
					£45,952	0	3
" Surplus at 30th June, 1889	...	405	13	10			
" Balance from Profit and Loss Account	...	201	17	7			
					203	16	3
					£46,155	16	6
CR.		£	s.	d.	£	s.	d.
By Preliminary Expenses, Balance from June, 1889...	...	800	0	0			
Add Broker's Commission, &c.	...	1,600	0	0			
		£2,400	0	0			
Less written off	...	400	0	0			
					2,000	0	0
" Plant (as valued)	...				7,082	18	6
" Stock in England (as valued)...	...				17,766	1	6
" Stock in New Zealand (at cost)	...				1,048	6	3
" Installation at Wellington, N.Z. (at cost)	...				13,486	13	3
" Trade Debtors	...				4,680	17	4
" Bills receivable	...				69	3	9
" Cash in hand	...				21	15	11
					£46,155	16	6

I have examined the above balance-sheet with the books and vouchers at the offices of the company, and I hereby certify the same to be correct.

RUSSELL DAY, Auditor.

December 6th, 1890.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. (The traffic receipts for the week ending November 28th were £8,361; and for the week ending December 5th were £5,855.)

The Great Northern Telegraph Company, Limited. The receipts for the month of November amounted to £23,600; 1st January—30th November, 1890, £266,400 as against £252,400 for the corresponding months of 1889, and £250,200 for the corresponding months of 1888.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (December 4.)	Closing Quotation. (December 11.)	Business done during week ending December 11, 1890.	
					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	98 — 101		
1,381,380	Anglo-American Telegraph, Limited	Stock	48½ — 49½	48½ — 49½		
2,809,310	Do. do. 6 p. c. Preferred	Stock	85 — 86	85½ — 86½	86	85½
2,809,310	Do. do. Deferred	Stock	13½ — 14	13½ — 13½	13½	13½
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 11½	11½ — 11½	11½	10½
84,500	Do. do. 5 p. c. Bonds	100	101 — 103	101 — 103		
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 — 108	104 — 108		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 1½	1½ — 1½		
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2		
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	102 — 104	104½	
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	7½ — 7½	7½ — 7½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	54 — 54½	54 — 54½		
16,900	Cuba Telegraph, Limited	10	11½ — 12	11½ — 12		
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	17½	17
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4½	3½ — 4½		
6,090	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14	13½ — 14½	14½	13½
70,000	Do. do. 6 p. c. Preference	10	14½ — 15	14½ — 15½	15½	14½
200,000	Do. do. 5 p. c. Debs. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109	108½	
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	103 — 106	104 — 107	105½	105½
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13½ — 14	13½ — 14½	14½	13½
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	101 — 103	101 — 103		
91,800	{ Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326 }	{ 100 }	{ 102 — 105 }	{ 102 — 105 }		
325,200	Do. do. Bearer Nos. 1,050—3,975 and 4,327—6,400	100	102 — 105	102 — 105		
145,300	{ Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	{ 100 }	{ 101 — 104 }	{ 101 — 104 }		
198,200	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 — 104	101 — 104		
201,600	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2,016	100	...	...		
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8½	7½ — 8½	8½	8½
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 1 to 70,000	2	3½ — 4	3½ — 4	3½	
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 pm. all pd.	2	1½ — 2½	1½ — 2½		
20,000	Fowler-Waring Cables, Nos. 301 to 20,000	5	2½ — 3½	2½ — 3½		
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9	8½ — 9	8½	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 14½	14½ — 14½	14½	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	15½ — 16½	16½	16½
15,000	Do. do. 5 p. c. Debs. (issue of 1881)	100	101 — 104	101 — 104		
230,000	Do. do. do. (issue of 1883)	100	104 — 107½	104 — 107		
9,384	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	11½ — 12½		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12	11½ — 12½		
41,800	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18 — 19	18½ — 19½	19½	18½
200,000	Do. do. 4½ p. c. Deb., 1896	100	100 — 102	100 — 102	101½	
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37		
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 (£10 p.)	10	9½ — 10	9½ — 10		
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	9½ — 10	9½ — 10		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. 6 p. c. Debentures	100	105 — 109	106 — 109		
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 £8 pd.	10	6½ — 7½	7 — 7½	7½	7
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4½ — 4½	4½ — 4½	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 12½	12½ — 12½	12½	
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½ — 10½	9½ — 10½	10	
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8½ — 9	8½ — 9	8½	
9,000	Reuter's, Limited	8	8½ — 9	8½ — 9	8½	
209,750	{ South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000 }	{ 1 }	{ 1 — 3 }	{ 1 — 3 }		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3		
3,381	Submarine Cables Trust	Cert.	108 — 112	108 — 112	109½	109
78,949	Swan United Electric Light, Limited	5	4½ — 5	4½ — 5	4½	4½
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45	44½	44½
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4		
146,128	Do. do. 5 p. c. Debenture Stock	Stock	90 — 95	90 — 95		
3,200	Do. do. 7 p. c. Debs., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½ — 9½	8½ — 9½		
290,900	Do. do. 5 p. c. Debentures	100	98 — 101	98 — 101		
30,000	West Coast of America Telegraph, Limited	10	3½ — 4½	2 — 4	2½	
150,000	Do. do. 8 p. c. Debs, repay. 1902	100	102 — 107	101 — 106		
64,174	Western and Brazilian Telegraph, Limited	15	10½ — 11½	10½ — 11½	11	10½
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 6½	6½ — 6½	6½	
27,873	Do. do. do. 5 p. c. Deferred	7½	4½ — 5	4½ — 5	4½	
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106		
250,000	Do. do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106		
88,321	West India and Panama Telegraph, Limited	10	2½ — 3	2½ — 3½	3	
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 11½	11½ — 11½	11½	
4,669	Do. do. do. 6 p. c. 2nd Preference	10	11 — 12	11 — 12		
1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
175,100	Do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 2½	2½ — 2½		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium, 2½—2½.—House-to-House Company (£5 paid), 4½—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 1½—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/-—13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2½—2½.—Preference, 4½—4½.

BANK RATE OF DISCOUNT.—5 per cent. (4th December 1890).

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 682.)

## TIME CONSTANTS OF ELECTRO-MAGNETS.

I may here refer to some determinations made by M. Vaschy,\* respecting the co-efficients of self-induction of the electromagnets of a number of pieces of telegraphic apparatus. Of these I must only quote one result, which is very significant; it relates to the electro-magnet of a Morse receiver of the pattern habitually used on the French telegraph lines.

	L, in quadrants.
Bobbins, separately, without iron cores	0.233 and 0.265
Bobbins, separately, with iron cores ...	1.65 and 1.71
Bobbins, with cores joined by yoke, coils in series ...	6.37
Bobbins, with armature resting on poles ...	10.68

It is interesting to note how the perfecting of the magnetic circuit increases the self-induction.

Thanks to the kindness of Mr. Preece, I have been furnished with some most valuable information about the coefficients of self-induction, and the resistance of the standard pattern of relays, and other instruments which are used in the British postal telegraph service, from which data one is able to say exactly what the time constants of those instruments will be on a given circuit, and how long in their case the current will take to rise to any given fraction of its final value. Here let me refer to a very capital paper by Mr. Preece in an old number of the "Journal of the Society of Telegraph Engineers," a paper "On Shunts," in which he treats this question, not as perfectly as it could now be treated with the fuller knowledge we have in 1890, about the coefficients of self-induction, but in a very useful and practical way. He showed most completely that the more perfect the magnetic circuit is—though, of course, you are getting more magnetism from your current—the more is that current retarded. Mr. Preece's mode of experiment was extremely simple; he observed the throw of the galvanometer, when the circuit which contained the battery and the electromagnet was opened by a key which at the same moment connected the electro-magnet wires to the galvanometer. The throw of the galvanometer was assumed to represent the extra-current which flowed out. Fig. 56 represents a few of the

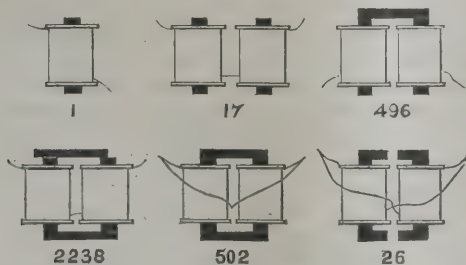


FIG. 56.—ELECTRO-MAGNETS OF RELAY, AND THEIR EFFECTS.

results of Mr. Preece's paper. Take from an ordinary relay a coil with its iron core, half the electro-magnet, so to speak, without any yoke or armature. Connect it up as described, and observe the throw given to the galvanometer. The amount of throw obtained from the single coil was taken as unity, and all others were compared with it. If you join up two such coils as they are usually joined, in series, but without any iron yoke across the cores, the throw was 17. Putting the iron yoke across the cores, to constitute a horseshoe form, 496 was the throw; that is to say, the tendency of this electro-magnet to retard the current was 496 times as great as that of the simple coil. But when an armature was put over the top the effect went up to 2,238. By the mere device of putting the coils in parallel, instead of in series, the 2,238 came down to 502, a little less than the quarter value which would have been expected. Lastly, when the armature and yoke were both of them split in the middle, as is done in fact in all the standard patterns of the British Postal Telegraph relays, the throw of the galvanometer was brought down from 502 to 26. Relays so constructed will work excessively rapidly. Mr. Preece states that with the old pattern of relay having so much self-induction as to give a galvanometer throw of 1,688, the speed of signalling was only from 50 to 60 words per minute; whereas, with the standard relays constructed on the new plan, the speed of signalling is from 400 to 450 words per minute. It is a very interesting and beautiful result to arrive at from the experimental study of these magnetic circuits.

\* Cantor Lecture. Delivered before the Society of Arts, February 3rd, 1890.

\* "Bulletin de la Société Internationale des Electriciens," 1886.

## SHORT CORES versus LONG CORES.

In considering the forms that are best for rapid action, it ought to be mentioned that the effects of hysteresis in retarding changes in the magnetisation of iron cores are much more noticeable in the case of nearly-closed magnetic circuits than in short pieces. Electro-magnets with iron armatures in contact across their poles will retain, after the current has been cut off, a very large part of their magnetism, even if the cores be of the softest of iron. But so soon as the armature is wrenched off the magnetism disappears. An air-gap in a magnetic circuit always tends to hasten demagnetising. A magnetic circuit composed of a long air-path and a short iron-path demagnetises itself much more rapidly than one composed of a short air-path and a long iron-path. In long pieces of iron the mutual action of the various parts tends to keep in them any magnetisation that they may possess; hence they are less readily demagnetised. In short pieces, where these mutual actions are feeble or almost absent, the magnetisation is less stable, and disappears almost instantly on the cessation of the magnetising force. Short bits and small spheres of iron have no "magnetic memory." Hence the cause of the commonly received opinion amongst telegraph engineers that for rapid work electro-magnets must have short cores. As we have seen, the only reason for employing long cores is to afford the requisite length for winding the wire which is necessary for carrying the needful circulation of current to force the magnetism across the air-gaps. If, for the sake of rapidity of action, length has to be sacrificed, then the coils must be heaped up more thickly on the short cores. The electro-magnets in American patterns of telegraphic apparatus usually have shorter cores, and a relatively greater thickness of winding upon them, than those of European patterns.

## LECTURE IV.—DELIVERED FEBRUARY 10TH, 1890.

## ELECTRO-MAGNETIC MECHANISM.

THE task before me to-night comprises the following matters:—First, to speak of that particular variety of the electro-magnet in which the iron core, instead of being attached to the coils, is movable, and is attracted into them. Secondly, to speak of the modes of equalising the pull of electro-magnets of various sorts over their range of action. Thirdly, to describe sundry mechanisms which depend on electro-magnets. Lastly, to discuss the modes of prevention or diminution of the sparking which is so almost invariably found to accompany the break of circuit when one is using an electro-magnet.

## THE COIL-AND-PLUNGER.

First, then, let me deal with the apparatus wherein an iron core is attracted into a tubular coil or solenoid, an apparatus which, for the sake of brevity, I take the liberty of naming as the *coil-and-plunger*. Now, from quite early times, from 1822 at any rate, it was known that a coil would attract a piece of iron into it, and that this action resembled somewhat the action of a piston going into a cylinder—resembled it, I mean to say, in possessing an extended range of action. The use of such a device as the coil-and-plunger was even patented in this country in 1846 under the name of "a new electro-magnet." Electro-magnetic engines, or motors, were made on this plan by Page, and afterwards by others, and it became generally known as a distinct device. But even now, if you inquire into the literature of the text-books to know what are the peculiar properties of the coil-and-plunger arrangement, you will find that the books give you next to no information. They are content to deal with the thing in very general terms by saying: here is a sort of sucking magnet; the core is attracted in. Some books go so far as to tell you that the pull is greatest when the core is about half way in, a statement which is true in one particular case, but false in a great many others. Another book tells you that the pull is greatest at a point one centimetre below the centre of the coil, for plungers of all different lengths—which is quite untrue. Another book tells you that a wide coil pulls less powerfully than a narrow one, a statement which is true for some cases and not for others. The books also give you some approximate rules, which, however, are very little to the point. The reason why this ought to receive much careful consideration is because in this mechanism of coil-and-plunger we have a real means not only of equalising, but also of vastly extending the range of the pull of the electro-magnet. Let us take a very simple example for the sake of contrasting the range of action of the ordinary electro-magnet with the range of action of the coil-and-plunger.

Here are some numbers which are given in a paper with which I have long been familiar, a paper read by the late Mr. Robert Hunt in 1856 before the Institution of Civil Engineers, and discussed, with that eminent engineer, Robert Stephenson, in the chair. Mr. Hunt described the various types of motors, and spoke of this question of the range of action. He recounted some experiments of his own in which the following was the range of action. There was a horse-shoe electro-magnet which at a distance zero—that is, when its armature was in contact—pulled with a pull of 220 lbs.; when the distance was made only  $\frac{1}{1000}$ th of an inch (4 mils), the pull fell to 90; and when the distance was increased to 20 mils ( $\frac{1}{50}$ th of an inch), the pull fell to only 36 lbs. The difference from 220 to 36 was within a range of  $\frac{1}{50}$ th of an inch. He contrasts this with the results given by another mechanism, not quite the simple coil

and plunger, but a variety of electro-magnet brought out about the year 1845 by a Dane living in Liverpool named Hjörth, wherein a sort of hollow truncated cone of iron (fig. 57), with coils wound upon it—a hollow electro-magnet, in fact—was caused to act on another electro-magnet, one being caused to plunge into the other. Now we have no information what the pull was at

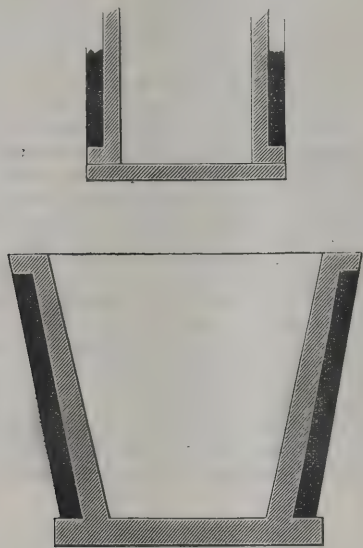


FIG. 57.—HJÖRTH'S ELECTRO-MAGNETIC MECHANISM.

distance zero with this curious arrangement of Hjörth's, but at a distance of 1 inch the pull (with a very much larger apparatus than Hunt's) was 160 lbs., the pull at 3 inches was 88 lbs., at 5 inches 72 lbs. Here, then, we have a range of action going not over  $\frac{1}{10}$ th of an inch, but over 5 inches, and falling not from 220 to 36, but from 160 to 72, obviously a much more equable kind of range. At the Institution of Civil Engineers on that occasion, a number of the most celebrated men, Joule, Cowper, Sir William Thomson, Mr. Justice Grove, and Professor Tyndall discussed these matters—discussed them up and down—from the point of view of range of action, and from the point of view of the fact that there was no means of working them at that time except by the consumption of zinc in a primary battery; and they all came to the conclusion that electric motors would never pay. Robert Stephenson summed up the debate at the end in the following words:—"In closing the discussion," he remarked, "there could be no doubt from what had been said that the application of voltaic electricity, in whatever shape it might be developed, was entirely out of the question commercially speaking. Without, however, considering the subject in that point of view, the mechanical applications seemed to involve almost insuperable difficulties. The power exhibited by electro-magnetism, though very great, extended through so small a space as to be practically useless. A powerful magnet might be compared, for the sake of illustration, to a steam engine with an enormous piston, but with an exceedingly short stroke; such an arrangement was well known to be very undesirable."

Well, from the discussion in 1856—when this question of the length of range was so distinctly set forth—down to the present, there have been a large number of attempts to ascertain exactly how to design a long range electro-magnet, and those who have succeeded have, as a general rule, not been the theorists; rather they have been men compelled by force of circumstances to arrive at their result by some kind of—shall we call it—"designing eye," by having a sort of intuitive perception of what was wanted, and going about it in some rough and ready way of their own. Indeed, I am afraid had they tried to get much light from calculations based on orthodox notions respecting the surface distribution of magnetism, and all that kind of thing, they would not have been much helped. There is our old friend, the law of inverse squares, which would of course turn up the first thing, and they would be told that it would be impossible to have a magnet that pulled equally through any range, because the pull was certain to vary inversely according to the square of the distance. I notice that, in a report of my second lecture in one of the London journals, I am announced to have said that the law of inverse squares did not apply to electric forces. I beg to remark that I have said no such thing. It is well to be precise as to what one does say. There has been a lively discussion going on quite lately whether sound varies as the square of the distance—or rather, whether the intensity of it does—and the people who dispute on both sides of the case do not seem to know what the law of inverse squares means. I have also seen the statement made last week in the columns of the *Times* by one who is supposed to be an eminent authority on eyesight, that the intensity of the colour of a scarlet geranium varies inversely with the square of the distance from which you see it. More utter nonsense was never written. The fact is, the law of inverse squares, which is a perfectly true mathematical law, is true not only for electricity but for light, for sound, and for everything else, provided it is applied to the one case to which a law of inverse squares is applic-

able. That law is a law expressing the way in which action at a distance falls off when the thing from which the action is proceeding is so small compared with the distance in question that it may be regarded as a point. The law of inverse squares is the law universal of action proceeding from a point. The music of an orchestra at 10 feet distance is not four times as loud as at 20 feet distance; for the size of an orchestra cannot be regarded as a mere point in comparison with these distances. If you can conceive of an object giving out a sound, and the object being so small in relation to the distance at which you are away from it, that it is a point, the law of inverse squares is all right for that, not for the intensity of your hearing, but for the intensity of that to which your sensation is directed. In no case, however, are sensations absolutely proportional to their causes. When the magnetic action proceeds from something so small that it may be regarded as a point compared with the distance, then the law of inverse squares is necessarily and mathematically true.

You may remember that I produced an apparatus (fig. 27) which I said was the only apparatus hitherto devised which did directly prove experimentally the law of inverse squares for the case of a magnetic pole. There was in it a pole, virtually a point at a considerable distance from a small magnetic needle, which was also virtually a point.

The law of inverse squares is true; but it is not what one works with when one deals with electro-magnets having ends of a visible size, acting on armatures themselves of visible sizes, and quite close to them. If you take a case which never occurs in practice, an armature of hard steel, permanently magnetised, so far away from an electro-magnet (or rather from one pole only) that the distance between the one pole and the armature on which you are acting is so very great compared with each of them, that each of them may be regarded by comparison as a point, then the law of inverse squares may be rightly applied, but not unless.

Now we want to arrive at a true law. We want to know exactly what the law of action of the coil and plunger is. It is not a very difficult thing to work out, provided you get hold of the right ideas. We must begin with a simple case, that of a short coil consisting of but one turn acting on a single point pole. From this we may proceed to consider the effect on a point pole of a long tube of coil. Then we may go on to a more complex case of the tube coil acting on a very long iron core; and, last of all, from the very long iron core we may pass to the case of a short core.

You all know how a long tube of coil such as this will act on an iron core. Let us make an experiment with it. I turn on the current so that it circulates around the coil along the tube, and when I hold in front of the aperture of the tube this rod of soft iron, it is sucked into the coil. When I pull it out a little way it runs back, as with a spring. The current happens to be a strong one—about 25 amperes; there are about 700 turns of wire on the coil. The rod is about 1 inch in diameter and 20 inches long. So great is the pull that I cannot pull it entirely out. The pull was very small when the rod was outside, but as soon as it gets in it is pulled actively, runs in, and settles down with the ends equally protruding. The tubular coil I have been using is about 14 inches long; but now let us consider a shorter coil. Here is one here only half-an-inch from one end to the other, but I have one somewhere still shorter, so short that the length, parallel to the axis, is very small compared with the diameter of the aperture within. The wire on it consists of but one single turn. Taking such a coil, treating it as only one single ring, with the current going once round, in what way does it act on a magnet that is placed on the axis? First of all, take the case of a very long, permanently magnetised steel magnet, so long, indeed, that any action on the

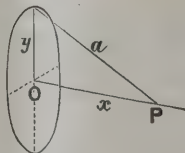


FIG. 58.—ACTION OF SINGLE COIL ON POINT-POLE ON AXIS.

more distant pole is so feeble that it may be disregarded altogether, and only one pole, say the north pole, is near the coil. In what way will that single turn of coil act on that single pole? This is the rule, that the pull does not vary inversely as the square of the distance, nor as any power at all of the distance measured straight along the axis, but inversely as the cube of the slant distance. Let the point *o* in fig. 58 represent the centre of the ring, its radius being *y*. The line, *o p*, is the axis of the ring, and the distance from *o* to *p* we will call *x*. The slant distance from *p* to the ring we call *a*. Then the pull on the axis towards the centre of this coil varies inversely as the cube of *a*. That law can be plotted out in a curve for the sake of observing the variations of pull at various points along the axis. Allow me to draw your attention to fig. 59, which represents a section or edge view of the coil. At various distances right and left of the coil are plotted out vertically the corresponding force, the calculations being made for a current of 10 amperes, circulating once around a ring of 1 centimetre radius. The force with which such a current acts on a magnetic pole of unit strength placed at the central point is 6.28 dynes. If the pole is moved away down the axis, the pull is diminished; at a distance away equal in length to the

radius it has fallen to 2.22 dynes. At a distance equal to twice the radius, or one diameter, it is only 0.56 dynes, less than one-tenth of what it was at the centre. At 2 diameters it has fallen

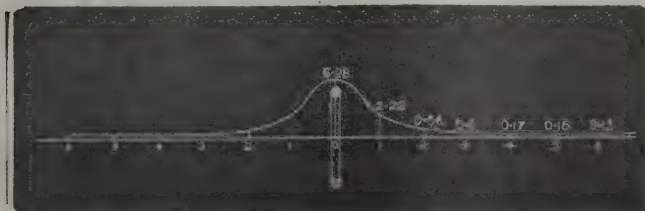


FIG. 59.—ACTION ALONG AXIS OF SINGLE COIL.

to 0.17 dyne, or less than 3 per cent.; and the force at 3 diameters is only about 2 per cent. of that at the centre.

(To be continued.)

## NEW PATENTS—1890.

18491. "Improvements in dynamo-electric machines." R. KENNEDY. Dated November 17. (Complete.)

18537. "Improved method of signalling on railways, and appliances connected for electrically operating same." E. S. COOK. Dated November 17.

18554. "Improvements relating to the fixing in insulating bases of blocks for connecting electrical conductors." H. J. PIERCE. Dated November 17.

18555. "Improvements in electrical switches." H. J. PIERCE. Dated November 17.

18556. "Improvements in electrical switches." H. J. PIERCE. Dated November 17.

18557. "Improvements in electrical switches." H. J. PIERCE. Dated November 17.

18558. "Improvements relating to electrical pendants and other portable or movable electrical devices." H. J. PIERCE. Dated November 17.

18576. "Improvements in apparatus for controlling electric currents." R. H. C. NEVILLE. Dated November 18. (Complete.)

18587. "Improved form of electric locomotive." J. PLATT. (Communicated by F. W. Dean, United States.) Dated November 18.

18589. "Improvements in electric railway signals." W. H. WADDELL. Dated November 18. (Complete.)

18625. "Improvements in and relating to apparatus for use in electric welding, forging, and other metal-working operations." H. H. LAKE. (Communicated by H. Lemp, United States.) Dated November 18. (Complete.)

18631. "Improvements relating to the welding of metals by electricity." H. H. LAKE. (Communicated by E. Thomson, United States.) Dated November 18. (Complete.)

18638. "Improvements in electricity meters." E. HARTMANN and W. BRAUN. Dated November 18. (Complete.)

18660. "An improved terminal for electric lampholders." A. J. MCGEOCH. Dated November 18.

18776. "Electric telegraphic communication between termini, intermediate stations, &c., and railway trams or vehicles in motion." A. T. J. CUTMORE, and F. H. BOINTON. Dated November 20.

18890. "Improvements in automatic telephone connectors." J. Y. JOHNSON. (Communicated by the Automatic Electric Exchange Company, United States.) Dated November 21.

18896. "Improvements in the process and apparatus for manufacturing copper tubes, sheets, strips, and wires by electrolysis." A. S. ELMORE. Dated November 21. (Complete.)

18904. "Improvements in magneto-electric telephonic apparatus." H. T. O. FRASER. Dated November 21.

18910. "Improved apparatus for stopping machinery by electricity." C. F. JOSZ. Dated November 21.

18913. "An improved electrical switch." E. L. JOSEPH. Dated November 21.

18969. "An improved apparatus for measuring the resistance and insulation of electric conductors." W. A. PRICE and W. E. GRAY. Dated November 22.

18993. "Improvements in and relating to electric clocks." N. PROKHOROFF and N. FAHLBERG. Dated November 22. (Complete.)

ducting portions, a socket and a spring, lying against and insulated from the former by means of ebonite or the like. 4 claims.

15963. "Improvements in the manufacture of electrodes or plates for electrical batteries." Dr. PAUL SCHOOP. Dated October 10. 6d. A compound soluble lead salt is decomposed by an electric current, its constituent parts being deposited upon suitably-shaped conducting plates or supports. Such a compound salt may be prepared by mixing sulpho-glycerine acid or naphthalin-sulpho acid, or both, with sulphuric acid, and adding thereto an oxide or carbonate of lead and one or more of the alkalies, potash, soda, or ammonia, until the acids are neutralised or saturated. 7 claims.

17521. "Improvements in the distribution and regulation of electric currents." W. CLARK. (A communication from abroad by S. Schuckert & Co., of Nürnberg.) Dated November 4. 11d. Consists:—1. In a system of distribution designed for a uniform tension of consumption and receiving electric energy from two or more current supply circuits (a) to regulate tensions at the terminals of all the supply leads with variable consumption of current, and (b) to allow of unequal falls of tension in the several supply leads with a maximum consumption of current. 2. At places where variation in the intensity of the light is required, to allow of the alteration of the tension of the lamps according to the brightness desired, both being effected without the usual resistances which consume uselessly a portion of the electrical energy, and convert the same into heat. 9 claims.

18821. "Improvements in electric baths, or apparatus for applying electricity for medical or other similar purposes." Dr. GUSTAV GAERTNER. Dated November 23. 8d. The inventor divides the bath into two perfectly separate compartments or cells by means of a partition made in two parts. The lower part of this partition is permanently united to the sides and to the bottom of the bath, but the upper part is capable of being removed, or of sliding upwards and downwards in guides, so as to be capable of joining the lower part, and forming with the latter a partition, making a tight joint with the sides and bottom of the bath. Both the upper and the lower divisions of this partition are cut away so as to form an opening between them, the edges of which are provided with India-rubber cushions or pads. Suitable electrodes or metal plates are provided around the interior of the bath at the sides, and those in one compartment are connected with the positive pole, and those in the other compartment with the negative pole of the electric generator or source of electricity. Inside these electrodes or plates a wood lining may be provided. 2 claims.

18939. "Improvements in and connected with railway and tramway vehicles and with their propulsion by means of electricity." H. P. HOLT. Dated November 26. 8d. According to these improvements the body of each vehicle is carried on two bogies, one at each end of the vehicle; but instead of the bogies being entirely below the under-framing, as in ordinary cases, it is arranged that the ends only of the vehicles shall rest upon and be carried by less than one-half of each bogie. 6 claims.

## 1890.

1037. "Improvements in mechanical telephones." R. C. M. BOWLES. Dated January 21. 6d. Consists in suspending or holding the telephone upon the line wire without other support than the wire itself, and then providing means for holding the diaphragm of the telephone under a tension equal to, or proportionate to, that line wire, and it further consists in providing means for adjusting the tension of the diaphragm. 4 claims.

2986. "Improvements in electric lamp sockets and devices attached thereto for regulating the light." W. F. WOLLIN and E. H. WEBERLINE. Dated February 25. 8d. The object of this invention is to provide means for controlling the intensity of the light of an incandescent electric lamp, so that it may be of any degree desired, as is the case with the flame of an ordinary gas burner. 7 claims.

3455. "Improvements in and relating to electric secondary batteries or accumulators." H. H. LAKE. (Communicated from abroad by T. Ewing, of New York.) Dated March 4. 8d. Relates first to a new construction of storage cell, and consists in the combination of the electrodes with the supporting bridge pieces of non-conducting material, with the interposed supporting and spacing bars of like material, and with the bolts or other means of clamping the various parts into a united body; and second, in a new method of preparing active material for use in storage cells, and preferably in cells of the form set forth. 8 claims.

3787. "Improvements in electric railways." H. W. LIBBEY. Dated March 10. 8d. Consists in the peculiar construction of the track and its supports, the construction of the car and the manner of mounting the same, and also in the construction of the switch and the means of shifting a car from an upper to a lower track, or vice versa. 10 claims.

4407. "Improvements in electric railways." J. B. MCGREW. Dated March 21. 8d. Relates to underground conduit electric railways. 7 claims.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS 1889.

11941. "Improvements in switchboards for telephone exchange." MIX and GENEST and W. OESTERREICH, Germany. Dated July 27. 8d. Each switch-hole consists merely of two con-

5344. "Improvements in apparatus for measuring the strength and electromotive force of electric currents." H. H. LAKE. (Communicated from abroad by M. M. Garver, of America.) Dated April 8. 8d. Consists in apparatus for measuring the strength and electromotive force of currents of electricity. In accordance with the special construction adopted, the instrument may be arranged either as an ammeter or device for measuring the strength of a current in amperes, or as a voltmeter for measuring the electromotive force of a current in volts. 10 claims.

5782. "An electric lamp for water closets." A. HIORTH. Dated April 16. 6d. The object of this invention is to provide a means for throwing electric light on the seat of water closets by raising the lid, thereby allowing the user to ascertain whether the seat is clean and the closet generally in proper order. 1 claim.

## CORRESPONDENCE.

### Telegraph Statistics.

The statistical notice in your No. of November 28th, "Use of the Telegraph," is wrong in all figures except in those concerning Great Britain. The correct figures, showing the number of telegrams for every 100 inhabitants (1888) are as follows: Great Britain, 140; France, 80; Germany, 42; Italy, 30; Austria, 22; Hungary, 19; Russia, 9.

The respective figures for 1889, if you care to know, are, according to the reports made by the Telegraph Administrations to the International Telegraph Bureau at Berne are: Great Britain, 163; France, 88; Germany, 45; Italy, 26; Austria, 20; Hungary, 19; Russia, 9. The rhapsodic correspondent of *La Lumière Electrique* must tune down his dithyrambic; he may see from this that his country's civilisation, its industrial progress and intelligence, are just half way to those of Great Britain, and not so very close as he deems fit to infer from incorrect figures.

F. Hennicke,  
Leipzigerstr., 15, G.P.O.

Berlin, W., December 6th, 1890.

### Count Mattei's Coloured Electricities.

My attention has been called to your notice in the November 21st number of your Journal of my published analysis of Count Mattei's so-called "Electricities." You very properly take exception to the inaccurate statements purporting to show they are not electrical. Permit me to explain. I did not anywhere publish the report. Mistakes have occurred in the publication. The words "electrical" (except when quoted as the name of the preparations) should in every case have been printed "magnetic." The absence of electrical properties was shown by the use of the gold leaf electroscope, and by pith-balls. Unfortunately this was omitted in the report as published.

As an old pupil of the late Prof. Guthrie, whose certificate I gained at the Royal School of Mines, I am not likely to confuse electricity with magnetism, or to be anxious, as your last words suggest, to bolster up anything in the way of quackery.

While pointing out such an inaccuracy of nomenclature, it would have done even greater service to science had you further pointed out the utter absurdity of pretending to thus bottle up either electricity or magnetism in liquids for curative purposes. Your Journal is so widely quoted that an authoritative statement from you would do great good in such a matter.

To the scientific mind it may seem even puerile to attempt to show scientifically that such claims are untrue, but, unhappily, it is necessary to do so for the benefit of the general public. Who else would believe it for want of any attempt at disproof.

Alf. W. Stokes.

[We are very pleased to insert this letter, and we hope that our correspondent's disclaimer will meet with general publicity.—EDS. ELEC. REV.]

### Electric Light on Shipboard.

In his interesting letter on the above subject in your last issue, Mr. Rankin Kennedy says:—"The lead-covered wire, without a continuous insulation of vulcanised rubber, is a failure on board ship."

As this statement is not borne out by facts—at all events so far as my own experience is concerned in the lighting of ships of war—it seems to me well that it should be questioned.

The English Admiralty have now for some years employed for a large number of their ships lead-covered cable, with insulation composed of yarn impregnated with bitumen, and as they still continue to specify this combination, it is presumable that they find it to be satisfactory in practice.

Messrs. Sir W. G. Armstrong, Mitchell & Co., of Elswick, have also employed similarly insulated and protected wire and cable throughout a number of war vessels, and I am able to state that with due care in jointing, and in seeing that the cable was both properly handled during the process of fixing, and well made in the first instance, the results have been good.

With insulation of this class it is, of course, highly necessary that the sheathing be made perfectly watertight at all joints; but this is effected by lapping the insulated joint with sheet lead, or covering the joint with a lead sleeve and soldering the whole all round.

Mr. Kennedy's unsatisfactory experience may have been due to this operation having been imperfectly performed, or possibly in the cases on which he bases his opinion the cables may have been injured in erection, or fixed without protection in places where they were liable to violent mechanical wear and tear sufficient to perforate the lead covering. For such localities lead-sheathed cable, however insulated, is obviously unsuitable unless protected with an additional covering of wood or sheet iron.

Provided the joints are made thoroughly watertight, and the lead is maintained intact, the only places where moisture can find its way into the insulation is at the extremities of the wires. There is, however, no great difficulty in properly constructed fittings, suitably placed, in arranging that such ends are kept dry, and where necessary, the wires can be sealed into the fittings, so as to be practically watertight.

On board ship, even more than in the case of land installations, films of condensed moisture are very apt to become deposited on the slate or porcelain bases of switches, cut-outs, &c., and ship engineers are very liable to attribute the resulting defective insulation to bad cables and wires, when these are really in no way to blame.

I have found that in such instances the deficiency of insulation due to this condensed moisture can be removed by electrolysis, it being sufficient to connect one pole of the dynamo to the ship's plating through a safety resistance of one or two lamps, and the other to the lamp circuits, and run the dynamo for a few hours. This has the effect of decomposing the moisture, and the result as regards improved insulation is surprising.

A. A. C. Swinton.

December 8th, 1890.

### The Electro-Deposition of Copper.

With reference to your answers to the eight points selected by me, in which your statements with regard to the Elmore process were seriously incorrect, and in which you requested me to point out your mistakes, I would remark:—1. You accept my correction, but ask me for a statement as to the number of tanks and of amperes required for depositing 20 tons per week. Both these points are given in Dr. Hopkinson's report from which you have quoted, and I would be obliged by your inserting it in full. Yet, as the matter still seems to present some difficulty to your mind, I give the simple calculations.

Taking 1.18 grammes as the weight of copper deposited per ampere-hour, then 600 amperes for 150

hours, in 60 tanks, give  $1.18 \times 600 \times 150 \times 60 = 6,372$  kilos., or slightly more than 6 tons.

Four circuits, therefore, of 600 ampères, or 2,400 ampères in all, will give about 24 tons per week. By a similar calculation, we find that four circuits of 500 ampères each will give slightly over 20 tons per week.

With a current density of 16 ampères per square foot of cathode surface, each tank will require about 32 square feet of cathode, equivalent to a tube of about 10 feet long and 1 foot diameter, while the total cathode surface will amount to 7,680 square feet. We have, therefore, instead of 287,620 ampères, and 15,979 square feet of cathode surface, as given by you, somewhat over 2,000 ampères, and slightly less than 8,000 square feet of cathode surface.

2. I accept your disclaimer, but it is impossible to see the object of your calculations, except to support your contention, which is absolutely opposed to the experience of years, viz., "that to deposit 20 tons per week would involve the use of enormous tanks worked under conditions that would be impossible, except by a heavy outlay for tank space."

My 4th, 5th, 7th and 8th points have not been denied by you.

You state, however, that I claim that the Elmore process enables the size of the tanks to be reduced. This was not my statement.

A tank must be large enough to contain the article which is to be made in it, and this depends entirely upon the requirements of the trade.

I will repeat my statement in slightly different words, in order to make it as clear as possible.

*Cæteris paribus*, the weight of metal which can be deposited in a given time with a given tank plant, varies directly with the current density.

It may be stated with certainty that where coal is cheap, as in England, copper refiners would gladly work with a higher current density than they generally employ, if they could secure a good class of copper.

With regard to the remaining point (6), you endeavour to weaken the importance of the proofs I have brought forward substantiating the other seven points, by referring to them as "side issues."

I am, however, ready to accept your view that the sixth point is the crucial one.

Now, you quoted from M. Fontaine's book the cost of refining in the Norddeutsche Affinerie as £8 per ton, the other two establishments then mentioned working at over £12 per ton. You enquire from the former whether the figure is correct. The answer is just what might be expected.

They state the figure is incorrect.

This strengthens my point.

For as the price for electrically deposited copper in the open market is less than £8 per ton, and it is certain that they are not working at a loss, we may safely assume that it costs them less than £8 per ton.

Why then is Dr. Hopkinson's estimate of £5 per ton so far wrong?

Why, again, should this estimate "be trebled," as contended by you?

It is hardly consistent on your part to suggest now, as you appear to do, that if the price is so low, the Elmore Company will find their profit very small, owing to competition.

You fail, also, to distinguish between the price of the raw material produced in copper refineries, which afterwards has to be worked up into finished articles, and the price of the finished article which is produced by the Elmore method during the process of refining.

In answer to your two queries (a) and (b) on this point I would reply:—

(a) Copper articles produced by the Elmore process can compete most advantageously with copper otherwise prepared, and this in the case of articles for which there is a large demand, and in which the superiority of the article produced at once secures a market.

This point may be determined at once by comparing the market prices for articles such as are particularly adapted for production by the Elmore process with even the exaggerated cost assumed by you.

(b) The economies of the Elmore process are such as to enable the company to sell a superior article at current prices and leave a substantial profit.

W. Stepney Rawson.

December 9th, 1890.

P.S.—Referring, separately, to the letter of Mr. Desmond G. FitzGerald, I have only to say that as regards the work done in the tanks themselves it is immaterial whether they are in series or parallel; but for practical work there is an enormous difference.

The "parallel system" teems with practical difficulties, and I do not think it need be seriously discussed.

As I am not responsible in any way for the article in the New York *Electrical Engineer*, with which, I beg to inform you, I had nothing to do, I will not trouble to follow the several arguments by which Mr. FitzGerald endeavours to justify the employment of a parallel system of electro-depositing. I would simply ask him to be so good as to let your readers know where dynamos can be obtained which will, with a reasonable efficiency, give an output of, say, 100 H.P., with a terminal E.M.F. of 1 volt?

His letter points to the existence of such a machine, although a calculation of its internal resistance appears to place it in the same category as "the bath." Yet as the feasibility of a parallel system depends upon its existence, he, perhaps, can give us the necessary information. It would appear from Mr. FitzGerald's letter that he is responsible for the calculations in the original article, the errors of which I have pointed out, for he says (no doubt inadvertently), "only an outsider would suppose for a moment that our data in relation to a single tank were intended to imply, in case of extended operations, the construction of an enormous reservoir."

[In the above communication, Mr. Stepney Rawson's familiar 8 points again make their appearance. The letter reached us too late to comment upon it at any length, but it confirms the impression we expressed that the "absurdity" which was so very apparent in Mr. Rawson's previous letters, recoils on Mr. Rawson himself. Our correspondent says we have not "denied" some of his points, as he previously said we had not "answered" some others. They were all dealt with by us, and we see no reason whatever to add to what we have already said about them. On the new points raised in the letter, Mr. Rawson takes for granted that a price which is incorrect is incorrect in the direction he wants it to be. We are not satisfied that the reasons he gives settle the question. Many other points assume the success of the Elmore process, which is, of course, all very well for Mr. Rawson, but may be held under reserve by others. We may say, with all respect, that, in reply to our crucial questions, we expected something more than an italicised "can" and "are." There is a P.S. which shows Mr. Rawson to have been a diligent reader of Mr. FitzGerald's letter. We will leave Mr. FitzGerald to reply to the questions asked him, and for our part we ask Mr. Rawson to kindly refer again to Mr. FitzGerald's letter, where he will see the plural number is largely used throughout, as it almost invariably is in scientific articles or papers dealing with data actual or suppositious. Mr. Rawson must try again. He should not seize upon such slender data to father upon an individual an article for which the Editors of the ELECTRICAL REVIEW are alone responsible.—EDS. ELEC. REV.].

#### Reviews.

I will only so far break through the rules of journalistic etiquette as to say that your recent critique on my "Practical Electrical Notes," second edition, is somewhat severe.

But you make a direct misstatement when you say that the machines are undescribed. *Vide* page 164 *et seq.*

Now, as such a statement is likely to do my book real harm, and as it is quite incorrect, I trust you will do me the justice of inserting a correction in your next issue.

W. Perren Maycock.

[Our reviewer admits that there are descriptions, of the trade circular description, but they are not full enough to be of much value.—EDS. ELEC. REV.]

#### Improvements in Telephone Exchange Switchboards.

The articles in your impressions of October 24th and 31st on the above subject are, without question, of considerable interest to all persons connected with telephonic enterprise in this country, and perhaps in a greater degree to those who are in charge of foreign systems, and have not opportunities of making themselves personally acquainted with the various developments and improvements which are from time to time being made.

After carefully reading the two articles in question, it seems that something more may with advantage be said on the subject of switchboards for small exchanges. Without doubt, both the double and single cord systems have individual points which are valuable, and which cannot easily be obtained by combination, and it therefore becomes a question as to which system gives the greatest efficiency.

When comparing the two systems, it may, in the first place, be said that it is objectionable to have in a telephone circuit more contact points than are absolutely necessary. Therefore, in principle, the single cord system is preferable, and it remains to be seen whether this advantage can be retained in practice satisfactorily. I do not hesitate to say that it can, and that other advantages can also be obtained.

The points to be aimed at are :—

1. A celerity in operation and general efficiency.
2. Simplicity in the arrangement of the circuits, and freedom from more circuit breaks than are necessary.

With regard to these points—

1. (a) Mr. Kingsbury claims that the number of movements in effecting a connection and disconnection of two wires is the same on both boards. On the single cord board the three first movements given by Mr. Kingsbury are in reality of much less value than is attributed to them. They certainly are not equal to more than  $1\frac{1}{2}$  movements, as the plug used is the same in each movement, and any one who has been accustomed to operate both boards will find this to be so. Therefore, I make the operating of the single-cord board equal to, say,  $5\frac{1}{2}$  movements, and the double cord board to 7 movements. Mr. Kingsbury asserts that the double cord movements are done more quickly. I do not see what reason he can give, and in practice it is not the case. On single cord boards of the latest design only four movements are required, if an automatic ringing machine is employed, and five if the ringing has to be done by hand. Therefore, as far as celerity is concerned, the single cord system has the advantage.

(b) The single cord system has been in use for some years, and, when properly fitted, has, as far as I am aware, had no objection of importance brought against its efficiency.

2. As to simplicity of circuits, &c.—When two lines are connected on the single cord board there is only one point of contact, *i.e.*, that between the called plug and the calling jack. On the double cord board there are four, *i.e.*, two plug and spring jack contacts, and two contacts in the key which is inserted into each pair of cords to enable the operator to speak and ring. Every practical telephone man will agree that nothing gives more trouble than key contacts, and this is why they have been entirely done away with on the single cord boards.

It is evident that keys might have been fitted on the latter, and that if this had been done the movements required to effect a connection and disconnection would have been reduced to four as compared with seven on the double cord board.

Mr. Kingsbury refers to the size of the single cord board described in your article of October 24th, and I agree with him that it might be reduced, and this can be done without in any way causing the difficulty in the plugs as he suggests. This is not an important point, however, as it is not usual to place two one hundred line boards side by side. From some cause or other it is usually found advisable to put in a new board when the exchange outgrows the capacity of the existing one. The boards are made for 30, 50, 100, and 150 lines in the style shown in the diagram of October 24th. The canopy pattern board is used for larger sizes. The "cross connections" are therefore never necessary. Mr. Kingsbury points out that the double cord board which he advocates as being the best is only 23 inches wide, and is for 100 subscribers. "Thus 500 subscribers would occupy a space of less than 10 feet." I need only say that it would be quite impossible to work 500 subscribers in a space of 10 feet. In the majority of exchanges two operators are required for 100 to 130 subscribers, and seven to ten operators cannot work with a sitting space of 16 inches in the one case and 10 inches in the other.

I think it has been shown that there is a saving in operators' work on the single cord system, and that other advantages, such as absence of keys and their accompanying faults are obtained.

H. F. Jackson.

December 3rd, 1890.

Since writing the above letter I have seen the further correspondence in your issue of December 5th. Mr. Kingsbury writes at great length in explanation of his previous letter, but without, it seems to me, entering on any new ground with the exception of the question of accessibility. All the working parts of a single cord board can readily be reached from the back, whereas the operators must be interfered with if any fault occurs in the key-board of the double cord system.

H. F. Jackson.

December 8th, 1890.

#### Seeing by Electricity.

With reference to your note *re* "Seeing by Electricity," *Phainein* means to show. Granted; but we want to express not showing, but seeing by electricity. The positiveness of the assertion—"telope," is certainly not right, as "*ope*" represents nothing connected with the subject—appears crushing; but its author seems unaware that *ops* means the eye, and that "OP" is the root from which comes the words most commonly used in the Greek language with regard to sight, to wit, *omma*, the eye; *opsis*, sight; the fut. aor. pass. and pft. mid. of *horao*; and it would not be surprising if the words connected with *skopos*, which we get in telescope, and mean, generally, reflection based upon sight, were all derived from the same root. *Telephane* is a sweet-sounding word, but it does not quite fulfil the required conditions. Why did so severe a maker of words write *optikos* nom. masc. sing., and then *phanerous* acc. masc. pl.? *Teleopt* would not do, as by itself it might easily be supposed to mean—roasted from a distance.

A. C.

#### Incandescent Lamp Breakages.

Would you kindly inform me if any explanation can be offered as to the reason why fully 80 per cent. of breakages in lamp filaments occur from  $\frac{3}{16}$ th to  $\frac{1}{4}$ th above the spot where the end of the filament is cemented to the platinum.

The lamps to which I refer are Edison-Swan 55 v. 8 C.P., and are Brush capped. They are used for ship-lighting. Is it possible that vibration may be a prime factor as to the cause.

Hoping you will pardon my troubling you.

Walter Poyton,  
Electrician R.M.S., "Oroya."

December 7th, 1890.

# THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

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## ELECTRIC LIGHTING COMPLAINTS.

THE recent destructive fire at the Grosvenor Gallery station of the London Electric Supply Corporation, Limited, followed by a second disaster, which completely broke down the partially repaired transformers which had been previously damaged in the conflagration, has been the means of effectually stopping the supply of electrical energy to every customer in the district covered by the Corporation. How long this delay will continue we are unable to determine; but the misfortune which has befallen the supporters of the high tension scheme seems likely to be followed by a host of minor failures which will probably affect electric lighting companies generally. A glance at the columns of the *Times* reveals a state of affairs which does not, to a casual observer (that is if the Parliamentary question of Mr. R. Chamberlain, M.P., into the doings of a well-known supply company should be successful in throwing dust into the public eye), suggest that would-be consumers can yet place a proper degree of reliance in the *bonâ fides* of electric lighting systems. This gentleman has taken it upon himself to ask in the House whether the attention of the Board of Trade had been called "to a long continued default of the Chelsea Electric Supply Company to furnish the statutory current of 100 volts, and to the serious loss of illuminating power sustained by consumers in consequence?" He also desired to know whether the Board of Trade would take steps to compel the company "to keep faith with the public, or forfeit their concession?" Mr. Irving Courtenay, the chairman of the Chelsea Company, in a letter which appeared in our daily contemporary on Monday last, completely demolishes, to his own satisfaction, Mr. Chamberlain's implied charges, but as his communication is directly followed by another from the M.P., reiterating his Parliamentary statements, the public may not easily be able to discriminate between the rights and wrongs of the matter at issue.

Mr. Chamberlain contends that the lamps supplied

by the company are intended to be used at 100 volts terminal pressure, and he finds that, notwithstanding repeated complaints, he gets only 96 to 98 volts. He is apparently ignorant of the fact that the Board of Trade allows a variation above and below of 4 per cent., and it is on this point that the company justifies itself.

Mr. Chamberlain asserts that, with a pressure of, say, 2 to 4 per cent. below the specified voltage, he is left in semi-darkness; but in this he exaggerates, for Sir David Salomons has shown that for a loss of somewhat more than half the light, the fall in voltage must be about 10 per cent., whereas double illuminating power can be gained by an increase of 4 per cent. over the normal difference of potential. It is possible that the company might endeavour to keep nearer to the 100 volts for the sake of pleasing its customers; but, as we imagine the conditions under which supply is guaranteed are known to householders, it will be seen that the complaint, if any, should be directed not against the Chelsea Company but against the Board of Trade for having allowed so much latitude to suppliers.

There are other letters complaining of the uncertainty of all consumers getting current during the time when the London Electric Supply Corporation was generating electrical energy, but it is well known that in early days the demand was greater than the supply, and altogether we fear that the correspondence in the *Times* will have a damaging result upon electric lighting if some steps are not promptly taken to counteract its ill effects.

We have many times pointed out the difficulties which must be encountered in keeping the insulation of high-tension apparatus intact, and the interesting experiences of Mr. Gisbert Kapp, to which we refer in another column, completely bear out our contentions with regard to transformers. It will also be remembered that Mr. Ferranti's mains have come in for their share of criticism at our hands, and we cannot but think that the concluding remark in his letter (see our

Correspondence columns), with regard to his opinion on insulating materials, will not prepossess electricians in his favour, but, doubtless, the advocates of the insulator which he so ruthlessly puts aside will have something to say in its defence, although that is hardly required.

India-rubber has been tried and proven, although in some instances faulty design of leads, or ignorance of the precise purposes for which they were required, may have led to failure of insulation; but the Ferranti conductors have not yet been through that test of time which is necessary in order to show whether they confirm the views of their designer, or come to the end which has been prognosticated in other quarters. Mr. Ferranti's belief in his mains is unbounded, but he admits the difficulty of insulating both generators and transformers under an alternating difference of potential of 10,000 volts; now that work has been shut down for a time, would it be too much to ask the London Electric Supply Corporation to carefully consider its future, and to seriously entertain some modification in its high-pressure method, if that future is to be either technically or commercially successful?

The Corporation must not merely debate its own position *per se*, but it should give due consideration to the many firms whose work in wiring and fitting is largely dependent on the increasing number of its customers, for these contractors suffer as well as the public.

We have often urged that a failure, or even a partial stoppage of the Deptford works, would be disastrous to the electric lighting industry; we fear that the truth of our warnings, which were then disregarded, are beginning to make themselves apparent, and we would, as friends, also suggest to Mr. Ferranti the absolute necessity of thoroughly reconsidering his plans. He has now by sheer misfortune got the opportunity for which he has always asked, a period of inaction in which to bring every part of his producing and distributing plant into thorough order, and we trust that he will, notwithstanding a heavy secession of consumers, neither shorten the time that is necessary for perfecting his work, nor spare any effort which shall tend to render a repetition of the mishaps impossible in so far as human ingenuity can be sure.

To guard against men of Mr. Chamberlain's stamp, we would strongly advise electric light companies to hold as near to their undertakings as possible, and not to merely keep within the limits of the percentage allowance. Judging from the eulogistic terms in which some supporters of the Kensington House-to-House Electric Supply Company speak, it is not a serious matter to give customers exactly what they expect and to which they are entitled.

High-Pressure  
Alternating Mains.

FOLLOWING the reading of Mr. J. Swinburne's paper on "Alternating Current Condensers," at the Physical Society, there was a discussion which drifted from the subject of the paper into a speculation on the alleged rise of E.M.F. in the Ferranti mains. Prof. Ayrton

stated, and he was supported by several other speakers, that the difference of potential taken from a transformer at Deptford was 80 volts, whereas at the Grosvenor end it measured 100 volts. This enormous rise seemed inexplicable, and various theories were advanced with a view of accounting for the possibility of such a phenomenon. Prof. Ayrton referred to a conversation he had had with Mr. Ferranti, which revealed the fact that no direct measurements were made at the termini of the mains themselves, and it has occurred to us since that there might be an error somewhere, and it would be both instructive and interesting if the low-tension transformers at both ends were transposed, viz., the Deptford one to Grosvenor, and that of the Grosvenor to Deptford, and fresh measurements made. We have an idea that the results would then turn out differently, since it is just possible that the transformers themselves may be to blame for this variation; they do not always give that which they are "calculated" to produce, and it seems hardly credible that there could be an unexpected rise of 25 per cent. entirely due to inductive effects; the dimensions of both transformers, we assume, being similar. Mr. Kapp related an interesting experience of his own, when he fruitlessly endeavoured to transform 1,000 into 14,000 volts; he failed entirely in the attempt, in spite of all ordinary care with insulation, the high tension transformer breaking down in every case in a remarkably short space of time. Every day it seems to become more certain that the 10,000 volt craze is giving way, and it seems a great pity that several hundred thousand pounds should have been spent in proving that which could have been as conclusively shown with as many shillings.

Experiments with  
Selenium Cells.

THE last meeting of the Physical Society was unusually attractive. Mr. Shelford Bidwell, F.R.S., told us a great many useful facts about selenium cells and their behaviour, and he gave several experimental illustrations, the most effective of which points to practical applications. Mr. Bidwell connected one of his selenium cells with a delicate relay, which in its turn caused circuit to be established with an automatic switch and an electric lamp. So long as sufficient light impinged upon the selenium the electric lamp did not act, but directly the gas (or daylight in practice) diminished to a certain degree the electric lamp shone forth in its glory, and again became extinguished when its rival reappeared. The fact of any light going out could thus be signalled to a distant attendant, and this would be useful in case of ships' lights and numerous other purposes. The effect of different coloured glass interposed between the light and the cell revealed peculiar results upon the properties of the selenium, and Dr. Thompson suggested that one could almost imagine the near possibility of seeing by electricity if the effects of colours could be transmitted to distances in some analogous manner.

Professors on the  
Technical Press.

PROF. AYRTON, at the Institution of Electrical Engineers, gave his reply to the various points raised during the discussion of the papers on Secondary Batteries. We give an abstract of this reply, and we only refer here to certain remarks which fell from the professor's lips about scientific journals. His attention being called to a letter which Mr. Swinburne wrote to a contemporary a few years ago, Prof. Ayrton said that he could not be expected to read all the matter in an electrical journal,

considering that he had scarcely time to attend to his own correspondence, but almost in the same breath he opened a mild attack upon a leading article on Secondary Batteries which appeared in the *ELECTRICAL REVIEW* on the 25th July last. Prof. Ayrton devoted so much time and attention to this article that we shall discuss at an early opportunity the questions touched upon at last Thursday's meeting.

#### Unsatisfactory Work and its Results.

THAT misfortunes never come singly has been amply shown by the lamentable results of the recent fire at the Grosvenor Station; and even this is supplemented by a serious accident which has occurred at Nancy (France) where the Ferranti system is in use. In this case a horse was instantly killed through receiving a shock, whilst the rider or driver also received a shock, and had to be conveyed to the local hospital. The E.M.F. of the alternators was 2,400 volts, but the accident was not caused by the system employed, it being due to the loose method in which it had been carried out. The cables used are concentric, insulated with jute and hemp, and laid directly in the ground. Where branches and connections to subscribers are made, cast iron boxes, laid from 20 to 24 inches deep, are provided, and after the connections have been made the boxes are filled with *brei*, which is a kind of tar. Since the station was started the insulation of the cables has been found to be defective, and numerous "earths" have taken place—and no wonder. Now that a horse has been killed, and a man seriously injured, the Nancy authorities are investigating the causes of the accident.

#### Oil Engines.

IT is somewhat difficult to understand how oil or gas engines can be conveniently and economically employed for traction, tramcar, or fire engine purposes. Yet, of the three latest oil engines introduced, the makers of two of them state that their engines are very suitable for such purposes. In this connection an industrial contemporary (usually above suspicion), when describing a new oil engine a few weeks ago, actually reproduced the maker's statement to the above effect. It is, however, satisfactory to note that in the description last week of a new oil engine, for which such claims are put forward by the maker, our contemporary wisely refrains from giving them publication.

#### The Rubicon Passed.

THE feverish excitement which followed the floating of the Anglo-American Brush Electric Light Company is now past history, though doubtless there are still many victims who have reason to deplore their folly in attempting to become wealthy by a stroke of the pen. Though the fever is no longer violent, it still shows fitful signs of being in existence, but it is steadily diminishing, and a healthier state of things has resulted. Amusing accounts which used so frequently to come to hand of people's ideas of the electric light are no longer met with; even in the most out-of-the-way places a fairly just estimate of the commercial value of the electric light seems to be arrived at, the inevitable result being that sound trade is becoming brisk and prospects of a brilliant future for electric lighting daily become more certain. The powers being sought for by several municipalities for carrying out electric light work themselves are certain to lead to others following in their steps, and must lead to the employment of many electrical engineers, of whom there is not likely to be any dearth. The last 10 years has been not altogether an encouraging time, but those who have had the patience and stamina to hold on are now likely to reap their reward.

#### Lamp Rheostats.

OUR American contemporary, the *Electrical World*, in describing an arrangement of lamp socket, by which, on turning the switch, the amount of light obtainable can be graduated by successive steps, as in an ordinary gas burner, makes the statement that the amount of heat developed (in the graduating resistance) after an hour's burning is not so great as to render the socket unbearably warm, so that it will be seen that the loss through heat waste has been reduced to a minimum. It is perhaps almost unnecessary to point out that this notion is an utter fallacy, the amount of heat generated in any case is an invariable quantity, and because it is *masked*, as it were, it none the less exists. The users of incandescent lights have often asked, "Can you not furnish us a light which is capable of being turned down just as gas is?" We believe in most cases the object of the consumer in asking for this is not so much to diminish the light as to effect an apparent saving in money. Probably if he knew what a very small diminution in energy is saved when the illuminating power of a lamp is cut down to, say, one-half, he would not consider it worth while to have the contrivance he asks for, though there are cases, of course, where it would be useful.

#### Heavy Dividends Coming.

THE electric light companies of London must soon report progress to the Board of Trade; that is, they must take stock of themselves up to the last day of this month. It is said that there will be no dividends; but shareholders are not to trouble on that score, for it is believed that the companies have almost reached that point after which their receipts will be almost entirely clear profit. In other words, the cost of producing electrical energy for, say, double or treble the present number of lights, will be so little increased in proportion, that the income derived from future customers will be almost wholly available for making the fortunes of stockholders. This, at all events, is the purport of a long article in the *World* of Wednesday, and we must congratulate Mr. Edmund Yates in being able to place the subject so temptingly before his readers, many of whom will doubtless rise to the bait. Even if they do not move a yard beyond the present areas allotted to them, says our contemporary, the companies ought to make enormous fortunes over and over again before the end of their 42 years. We only hope they may.

#### Simple as A B C.

FURTHER on the *World* endeavours to show that electric lighting is so simple that the notion that there is something specially dangerous in it is sheer delusion. "You may, if you like, easily blow up your house with gas; the utmost mischief you can do with your electric wires is to spoil them." "The current is so weak when it enters your house that a baby may play with it." "What danger there is exists only at the central stations or at the subsidiary stations where the current is 'transformed' for customers." "The only damage to which customers are liable—that of being left in sudden darkness by an accident to the wires—is being obviated by double machinery and by connections between subsidiary stations." The *World's* electrical contributor makes things look bright commercially, but when he rises to technical points his remarks make one feel sad to think that there is so little to learn after all these years of study.

## THE EXPERIMENTAL DEMONSTRATION OF VALENCY BY ELECTRICITY.

It is impossible to proceed very far in the study of physics without trespassing upon the domains of the sister science, chemistry. Indeed, many of the most interesting questions which to-day engage the attention of scientists lie just on the borderland, as it were. The knowledge which has been acquired respecting the character of the "atom" and the "molecule" is entirely of a physico-chemical nature, and the pursuit of more knowledge respecting these obscure entities—if such they be—necessarily involves the services of the disciples of both sciences.

Leaving generalities, let us take a particular case. No electrician can hope to fully understand all that has been learnt respecting the internal working of a galvanic battery, much less can he hope to advance knowledge in this direction unless he have at least grasped the principles of the science of chemistry, and has made himself familiar with the various reactions and decompositions which are likely to result when substances are placed in intimate relation. And we take the opportunity of urging all such as are engaged in those departments of electricity which are concerned with the use of batteries, &c., to combine with their electrical knowledge a knowledge of the leading outlines of chemistry at the very least.

Most of our best electricians are tolerably good chemists. Few discoveries are now made *accidentally*; they are the result of intelligent, organised work and laborious investigation. There is, therefore, the greater need for thoroughness.

We have written in this strain more by way of apology than with the idea of leading up to a directly-interested question, although partly to introduce something which is perhaps of a more distinctly chemical than of an electrical nature.

Our readers may remember an illustrated article which appeared in our issue for October 24th on the subject of the action of the electric arc upon gaseous substances. The apparatus therein described may be utilised in order to demonstrate a most important matter in chemistry. And we commend it to the notice of such of our readers as have already embarked upon the right course, and combined with their knowledge of physics some knowledge also of the sister science.

In studying chemistry we are soon confronted with mysterious symbols which, to the uninitiated, are simply bewildering; but we soon find out that they are the "short-hand" of the science, and, moreover, that they assist us to perceive, and, if necessary, to explain, with great rapidity, matters which would otherwise be difficult to grasp.

Chemical formulæ, or symbols, are, to a great extent, based upon certain assumptions regarding those properties of atoms which are referred to under the name *valency*. It is found that the atomic weight of an element is, in some cases, equal to its combining weight, whilst in others it is twice, three times, four times, &c., as great. In other words, an atom of certain elements can be substituted for, or can replace, only one atom of hydrogen, whereas the atoms of other elements can replace 1, 2, 3, 4, &c., atoms of hydrogen. This difference of saturating, or combining power, called by the older chemists *atomicity*, is now appropriately termed *valency*.

The meaning of this term is rather difficult to explain experimentally; according to Lepsius, in a recent paper in the *Berichte der Deutschen Chemischen Gesellschaft*, the apparatus shown in the article which we have already referred to (see page 482) can be used with great success for illustrating this peculiar property of the element.

Four such apparatus of dimensions, each 35 mm. in diameter and 150, 200, 250, 300 cc. capacity respectively, are so arranged that the uppermost stop-cocks are all at the same level. They are then filled with equal volumes, say, about 100 cc. of the following gases: Hydrogen iodide [ $\text{HI}$ ], hydrogen sulphide

[ $\text{H}_2\text{S}$ ], hydrogen phosphide [ $\text{H}_3\text{P}$ ], and hydrogen carbide (methane) [ $\text{H}_4\text{C}$ ] respectively, the volume being marked on the tube immediately after the introduction of the gas.

The arc is now ignited by turning on the current in each of the four apparatus, either separately or simultaneously; this decomposes the gases into their several elemental constituents. They are then allowed to stand at rest for some time in order to allow the contents of the tubes to cool and the pressure therein to become adjusted. When these conditions are fulfilled the volume of the liberated hydrogen in the four tubes is seen to be in the ratio of

$$1 : 2 : 3 : 4$$

showing that the formulæ given above correctly express the relations of the constituents of the substances experimented on; in other words that iodine is monovalent, sulphur is divalent, phosphorus is trivalent, and carbon is tetravalent.

This apparatus may be advantageously used for lecture demonstrations.

## SOME FACTS CONCERNING GUTTA-PERCHA.

(Continued from page 708.)

THE third phase of the second of the two periods into which the history and investigation of gutta-percha are divided, is indicated by the explorations of M. Burck, the director of the botanical gardens at Buitenzorg.

The report of M. Seligman-Lui, on his return to France, impelled the French Government to ask the permission of Holland for the dispatch of a properly equipped expedition to explore Sumatra for the purpose of obtaining gutta-percha plants, with the object of attempting their cultivation in Cochin-China. This request was not granted, and the reason given for the refusal was that the natives of the interior, the Bataks, were divided into many tribes perpetually at war with one another, and the Government could not allow itself to be placed in a position of moral responsibility towards travellers over whom it could exercise no protecting influence. Strangely enough, at this very moment, M. Burck received instructions from the Dutch Government to undertake precisely the same investigations. It is to be presumed that the Bataks were then temporarily at peace with one another.

During the course of his explorations M. Burck observed 14 varieties of gutta-percha trees, among which he was only able to select two having any useful properties. These were the *Niatouh balam tembaga*, from Ampaloo, a species he described as being new, and giving a gum of excellent quality, and the *Payena Leerii*, well known already, and supplying a gum of second class quality.

The other specimens belonged to the following varieties:—

- Tembaga*, from Halaban.
- Bringin* and *Tembaga*, from Soupayang (the *Bringin* is nothing else but the *Payena Leerii*).
- Dourian*, from Halaban and Kayon Tanam.
- Pissang*, from Halaban.
- Bindalou*, from Halaban and Sagoh mountain.
- Selindit Pipit*, and three varieties of *Niatouh balam*, from Pouar-Dastar, Labouei, and Ampaloo.
- Niatouh balam*, from Glougour.

M. Burck brought back to the museum in Java the flowers and gum from the *niatouh balam tembaga*, but throughout the forests situated between Sialang and Glougour he only succeeded in discovering one adult growing specimen of this tree. He found, in every direction, nothing but large trunks lying where they had been cut down, and the natives assured him that the same condition of affairs existed in the districts of Sidjounjung. It took M. Burck a whole week to find the single specimen above referred to, and the forests

he explored were very little frequented, and have only recently been taken possession of by the Dutch Government. Some 75 young plants of the *niatouh balam tembaga* were obtained, and sent to the garden at Buitenzorg.

M. Sérullas proceeds to give an account of the circumstances which led to his investigations in search of a better variety of gutta-percha than discovered by late explorers, the idea of the French Government being to create a nursery at Saigon, so as to perpetuate, by cultivation, the better classes of percha so rapidly becoming extinct. No specimen of the *Isonandra* had been met with for more than 30 years, and the claims of the Buitenzorg gardens to the possession of young plants of that species were easily disproved. The plants obtained from the English and Dutch authorities were not of a suitable class, and those collected by M. Seligman-Lui had been lost.

The author, during the course of long exploration, met with a considerable number of adult trees of the *taban merah* and *taban soutra* among the forests frequented by wild and independent tribes on the Malay peninsula. Suffering from severe attacks of fever, M. Sérullas was compelled to seek relief in France, but, restored to health, he speedily returned to Malaysia, and, after much difficulty, succeeded in transporting to Singapore a number of the young plants of the two species above mentioned. While awaiting the decision of the Government of Cochinchina as to the disposal of the plants, M. Sérullas, greatly to his astonishment and delight, discovered *bona fide* specimens of the *Isonandra gutta Hookerii* in the ravines of Boukett Timah, in the interior of Singapore. This was indeed a fortunate chance, since for forty years the *isonandra gutta* had been searched for in vain.

On the communication of this discovery to the Governor at Saigon, the order for the transport of the young plants of the *Taban Merah* and *Taban Soutra* was revoked, and instructions given to send to Saigon the plants of the *Isonandra*. This was done, but notwithstanding all the careful advice given by M. Sérullas as to the treatment of the shoots, they were allowed to perish through want of attention. The seeds of the *Isonandra* were then obtained, and sent to Saigon, but M. Sérullas, in obtaining these seeds, became affected with chronic dysentery of so violent a form as to necessitate his return to France. His mission was abandoned, and the French Government ceased to give the matter any further attention. The young plants of the *taban merah* and *taban soutra* were left in the gardens at Singapore.

In attempting to arrive at some practical conclusion as to the results of the explorations undertaken by Government officials, M. Sérullas points out the errors into which many investigators have fallen. It has been too generally believed that there existed a particular and defined substance, possessing certain especial chemical characteristics, called *gutta-percha*, and all endeavours have been directed to the search of its vegetable source. Instead of looking for a tree whose coagulated sap assumed the form of a gum endowed with all the qualities required in the most delicate applications, the investigators devoted themselves to the elucidation of botanical problems, and to the discussion of questions of nomenclature and botanical classification. To M. Seligman-Lui may be given the credit of directing enquiries into the proper channels. The only type of gutta-percha possessing the necessary attributes, the *Isonandra*, was to be found in Singapore alone, and had not there been met with for more than a third of a century; under these conditions, it was not the same tree which should have been searched for, but a gutta-percha gum analogous to that supplied by the *Isonandra*.

But if the questions regarding trees producing gums of little value, where submarine telegraphy is concerned, are put on one side, it may be assumed that during the second period, that of official explorations, the question has received practical solution. Adult trees producing good guttas have been found; gums, together with botanical specimens, have been obtained from these trees, and it is known where to find them.

The only trees in Malaysia supplying a sap whose coagulation gives a thoroughly good gutta-percha are:—

The *Isonandra percha* or *Isonandra gutta Hookerii*, from Singapore; the *Gueutta-taban merah*, of Malacca; the *Niatouh balam Tembaga*, from Ampaloo (Halaban), Sumatra; the *Mayang-taban dourrian*, of Singgaloungan (Assahan), Sumatra; the *Gueutta-taban soutra*, from the Malay peninsula; and, finally, a tree, to be described later on, which differs but slightly from the preceding varieties, and whose trunk is supported by numerous aerial roots.

M. Sérullas states that the foregoing trees are not of different species in a botanical sense; that no considerable difference exists between their respective guttas; and that they may be considered as varieties of the same species.

The following methods for distinguishing in the forests these varieties from among other gutta-percha producing trees are practical, and are to be absolutely relied upon; (1) all sap which is a gutta-percha of the best class coagulates almost immediately it escapes from an incision made in the bark. This solidified sap becomes a stiff gum, much veined upon cooling after handling in hot water for two or three minutes.

(2) The leaves of these *isonandra* are covered on the under side with a fine, soft, and golden down in young plants and in fresh shoots. Later this down often becomes copper-coloured, and it sometimes disappears altogether in the old branches of large trees. Every *isonandra*, however, whether old or young, will have many leaves either gold or copper-coloured underneath.

(3) Every normal leaf presenting the foregoing features, and coming from a tree whose sap behaves as above indicated, will be found to have on each side of the principal vein from 22 to 35 very delicate and scarcely visible secondary veins; they are completely buried in the cellular tissue.

The preceding characteristics are only to be simultaneously found in the species *isonandra*, and the tree in which they appear may be relied upon to produce a gutta-percha of the best quality.

(To be continued.)

## THE ELECTROLYSIS BY IGNEOUS FUSION OF FLUORIDE OF ALUMINIUM.\*

By M. ADOLPHE MINET.

IN the two notes† which I have had the honour of presenting to the Academy, I showed that I had produced aluminium by the electrolysis of its fluoride in a melted state.

More recent experiments have enabled me to arrive definitely at the composition of the electrolytic bath, which for given values of the *temperature* and *density* of the current at the electrodes, corresponds to the best rendering obtained from the compound experimented upon; I also succeeded in determining the physical properties of the mixture of the salts in fusion, and establishing the formula which connects the constants of the current with those of the electrolyte at various periods.

*Composition of the bath, its properties and its regeneration.*—The bath is composed of a mixture of chloride of sodium and double fluoride of aluminium and sodium, corresponding to the chemical formula, expressed in equivalents:

$6 \text{ Na Cl} + \text{Al}_2 \text{ Fl}_2, 3 \text{ Na Fl}$ ; melting point,  $675^\circ$ ; boiling point,  $1,035^\circ$ ; density at  $820^\circ$ : 1.76; coefficient of dilatation in a melted state,  $5 \times 10^{-4}$ . Electrical conductivity at  $870^\circ$ : 3.1. The electrical conductivity, as a function of the temperature, is calculated by the equation:

$$C_t = 3.1 [1 + 0.0022 (t - 870^\circ)]$$

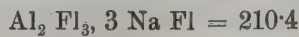
\* *Comptes Rendus de l'Académie des Sciences.*

† *Comptes Rendus*, February 17th, and June 9th, 1888.

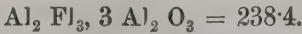
For a current having an intensity of 1,200 ampères, the mass of the bath is represented by a weight of 20 kg. In this case, the density of the current (intensity per square centimetre of active surface), at the positive pole is 1 ampère, the difference of potential is 5·5 volts at the electrodes. The composition of the bath is maintained constant, during the decomposition of the fluoride of aluminium by means of the following mixture. Hydrate of alumina partly dried :



Double fluoride of aluminum and sodium :



Oxifluoride of aluminium :



This mode of alimentation enables the two-thirds of the fluor given off at the positive pole to be replaced.

The bath is kept at the same level by the introduction of a mixture of chloride of sodium and double fluoride of aluminium and sodium, in the proportions given above.

*Relation between the constants of the current and those of the electrolyte.*—This problem resolves itself into two parts. Let  $\epsilon$  be the difference of potential at the electrodes ;  $e$  the electromotive force of decomposition ;  $\rho$  the resistance of the electrolyte, that of the electrodes being disregarded ;  $I$  the intensity of the current ;  $\delta$  the maximum density of the current at the electrodes, for each period studied.

A.—The salts composing the bath are chemically pure.

a. *First period*, from the point when the density of the current at the electrodes is equal to zero, to the point when it is such that the electromotive force of polarisation is of the same value as the electromotive force of decomposition of the electrolyte under consideration. For the lowest points, the difference of potential may be expressed by the relation  $\epsilon = K I$ , the temperature remaining constant. Towards the limit of density, the value of the difference of potential cannot be calculated by a simple formula ; I have, however, in certain cases, been able to determine the formula required. For a temperature of 870°, the maximum density of the current at the electrode, corresponding to the first period of the electrolysis of the bath experimented upon, varies between ·02 and ·03 of an ampère.

β. *Second Period.*—From the moment when the electromotive force of polarisation is equal to the electromotive force of decomposition of the electrolyte under consideration, to the moment when the density of current at the positive pole, with our bath of fluoride, reaches the value of 1 ampère, the difference of potential is expressed by the equation  $\epsilon = e + \rho I$ .

These are the actual figures of the experiment :—

Temperature 882°. $e = 2\cdot15.$ $\rho = \cdot01.$			Temperature 890°. $e = 2\cdot4.$ $\rho = \cdot0014.$			Temperature 980°. $e = \cdot34.$ $\rho = \cdot0033.$		
$\epsilon$			$\epsilon$			$\epsilon$		
I. amp.	Mea- sured volts.	Calcu- lated volts.	I. amp.	Mea- sured volts.	Calcu- lated volts.	I. amp.	Mea- sured volts.	Calcu- lated volts.
130	3·50	3·45	196	3·26	3·26	572	4·23	4·23
150	3·70	3·65	403	4·12	4·17	650	4·48	4·48
175	3·95	3·90	585	5·05	4·97	910	5·30	5·54
215	4·30	4·30	885	6·18	6·29	1,030	5·78	5·74
245	4·60	4·60	...	...	...	...	...	...

The density of the current at the negative pole is only limited by the dangerous heating due to the passage of the current.

γ. *Third Period.*—For densities of current above 1 ampère, the value of the difference of potential can no longer be calculated as a function of the intensity by a simple formula. It rapidly attains a value approaching that of an electric arc, or from 30 to 40 volts.

B. *The electrolyte is mixed with certain proportions of foreign salts ;* salts of iron and of silicium in the case we are discussing. When we keep the density of the current at the positive pole within certain limits, these salts are decomposed according to Sprague's law. These are the figures obtained with a bath from which the salts of iron and of silicium were successively eliminated.

Temperature 810°. (Salts of iron.) $e = \cdot75.$ $\rho = \cdot0093.$			Temperature 840°. (Salts of silicium.) $e = 1\cdot37.$ $\rho = \cdot0089.$			Temperature 870°. (Salts of aluminium.) $e = 2\cdot15.$ $\rho = \cdot0085.$		
$\epsilon$			$\epsilon$			$\epsilon$		
I. amp.	Mea- sured volts.	Calcu- lated volts.	I. amp.	Mea- sured volts.	Calcu- lated volts.	I. amp.	Mea- sured volts.	Calcu- lated volts.
75	1·45	1·45	65	1·95	1·95	100	3·00	3·75
147·5	2·20	2·11	137·5	2·65	2·61	130	3·28	3·00
225	2·85	2·85	217·5	3·35	3·31	187·5	3·75	3·25

It is to be remarked that in these last experiments the resistance,  $\rho$ , of the electrolyte remained constant, the composition of the bath of fluoride of aluminium being as indicated at the beginning of this note ; the salts of iron and silicium, which discoloured it, were in very small quantities.

We have also some observations to make with regard to a method of analysing the bath, to the apparatus for measuring the temperature and the electric current, to the phenomena that are observed when, after the passage of the current, the electrolyte re-acts as a secondary battery. These points will be treated in subsequent notes.—*Comptes Rendus*, October 27th, 1890.

THE COMPLEX NATURE OF ELECTROLYSIS.

FARADAY applied the term *electrolyte* to those substances which, like hydrochloric acid, are resolved into their elements by the passage of an electric current. To the act of decomposition by the voltaic battery he gave the name *electrolysis*. In most cases, if a liquid permit the passage of a current of electricity through it, it is decomposed by the conductor, or, in other words, most liquids which possess conductivity are also electrolytes. Of course there are exceptions to this rule ; some liquids, such, for instance, as alcohol and ether, although they are not absolutely non-conductive, are not capable of being decomposed by the passage of a current. The number of these apparent exceptions to the rule is becoming more and more limited as time goes on and they become better understood. Once people thought that acidulated water was the only liquid which could conduct the electric current ; but now it has been proved that a vast number of binary and ternary, and even more complex substances, are amenable to the general law.

The decomposition of a binary substance like hydrochloric acid (H Cl) is comparatively simple. One of the elements goes to the positive and the other to the negative pole.

The decomposition of a ternary salt is more complex. It was formerly explained by saying that the acid was liberated at the positive electrode and the base at the negative. Thus sodium sulphate,  $Na_2 O SO_3$ , was considered to be resolved into sulphuric acid  $SO_3$  and soda  $Na_2 O$ . But now the way of regarding this change has been modified. The sodium sulphate is supposed to split up into potassium, K, and the electro-negative group,  $S O_4$  ; the metal, K, being liberated at the negative electrode, decomposes the water, and in effecting the solution of the salt, forming potash and liberating free hydrogen. Similarly, the electro-negative group,  $S O_4$ , which cannot of itself

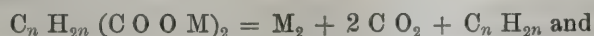
exist in a free state like  $\text{C O}_2$ , can, for instance, decompose into free oxygen gas ( $\text{O}$ ) which is evolved, and into anhydrous sulphuric acid ( $\text{S O}_3$ ), which immediately combines with water to form ordinary sulphuric acid, thus,



When we come to deal with still more complicated substances, the decomposition which ensue on their being subjected to the action of voltaic electricity are of a very involved nature. Berthelot, and some of the other French scientists of his school, have carried their researches into many an unexplored direction, and in connection with such research, the names of Kolbe, Kaempff, Brazier, Gossleth, Wurtz, Schoslemmer, and Kekulé, cannot avoid mention.

The latest work upon the electrolysis of complicated substances is reported from Russia, where, before one of the learned societies of St. Petersburg, N. Burp has read an important paper.

Burp considers that the reaction which takes place when fatty acids are subjected to electrolysis is a very complicated one, and cannot be represented by a simple chemical equation. He does not, however, support Kekulé's views. This scientist represented the decomposition of the fatty acids by the following general formulæ :—



But these equations do not represent facts according to Burp. He says the complicated groups are not decomposed into their negative constituents, but that they enter into reaction with water, reforming the original acid and oxygen, and that the latter, on being liberated, oxidises the electrolyte, and thus forms the different products.

The original paper contains a detailed description of Burp's apparatus, the preparation of the pure substances, and a large set of tabularly arranged analytical data of the gaseous products. It is shown also that the nature and relative quantity of the products obtained at the anode vary very considerably with varying concentrations, intensity of current, size and surface of the electrodes and especially with the temperature of the electrolyte.

The opinion on the complexity of the chemical process in the electrolysis of most substances was first pronounced by Bourgoni, and Burp says that his experiments entirely confirm this view.

## UNDERGROUND AND OVERHEAD ELECTRIC WORK.

IN undertaking underground electrical work, it is essential to provide a good and lasting insulating covering for the buried wires, and also some means of protecting the cables from mechanical injury. This is not all that is required, for, so soon as the switch boxes and other connections are joined on as part of the circuit, an insulation of 500 megohms per mile in the cable *per se* will drop to three or four megohms resistance, or even less; besides, after a time, from various causes, a cable may show a perceptible drop in insulation. This drop will often be permanent. In a cable insulated with India-rubber, contact with pitch or similar material has been known to lower the resistance of the rubber; but this does not materially damage the cable for practical purposes, beyond the lowering of insulation, as in other respects it is perfectly sound. The big drops in insulation do not arise from this sort of mishap, but more frequently, as Mr. Degenhardt states in a paper read before the Chicago Electric Club, from bad jointing, moisture, and insufficiently insulated switch boxes; and therefore, in selecting men to do the difficult work of making joints, it is well to secure those of high class character, and instil into their minds the fact that it is not how many joints they can make,

but how well they can do them. There is little to complain of in the quality of the cables employed, as manufacturers supplying them make them to meet the varying requirements of their customers, and accompanied with a guarantee. The underground work in Chicago is a success, proving what can be accomplished by an honest effort to comply with the ordinance of the Common Council, ordering all electric conductors to be placed beneath the surface of the streets. The area ways under the side walks was a favourable circumstance connected with this underground construction, practically forming a ready made conduit. Not every city in the States has this advantage. The conduits in which the cables are placed are of various kinds, viz.: iron pipe laid in the earth without any protection; iron pipe laid in concrete; iron pipe, cement lined, laid in concrete and multitubular blocks of bituminous concrete about 4 feet long. Manholes at intervals, with watertight double covers. The iron pipe used for the conduit is thoroughly reamed at the ends to remove the burr. All pipes are also laid with a grade to draw off condensation water into the manholes. Quite an elaborate set of tools and accessories has been devised for manipulating the cables. Of course, this underground service is not perfect; but we have it on the authority of Professor Barrett that it is safe, feasible, and practicable. With the exception, perhaps, of small cities with small service, overhead systems will soon be things of the past. The people wish to get rid of overhead high pressure wires, so do the electricians, but capitalists do not. The electric light people assemble together from time to time, and they tear the underground service all to pieces. None are so blind as the people who will not see; for instance, some two years back the City of New York appointed a delegation to visit Chicago and examine the underground service in that city. The gentlemen forming the delegation called on Prof. Barrett at his office, and were offered every facility to view the system. They did not avail themselves of the opportunity, but promptly returned home. They sent in a report stating that they had not seen a list of underground work in Chicago, which was true. Next year, one of them again called on the chief of the Telegraph Department, who said to him: "Do you want to make a report on underground work this time?" adding, on receiving an answer in the affirmative, "You are going to see the underground service this time." The delegate was then taken out and deposited in a manhole. If report may be believed, the above is not the only instance of jobbery perpetrated during the long-continued battle between the advocates of overhead and underground systems. It is charged against the upholders (shall we say the capitalists) of the overhead system that in order to bear out their assertion that underground electrical work for electric lighting was impracticable, they deliberately put down cables which they knew would not work, and by their failure produced spurious evidence against the rival system. It is not unreasonable to conjecture that the celebrated pole-chopping incident at New York was the outcome of some disclosure connected with this party spirit.

It is stated that the cost of running underground wires for arc lighting purposes, including cost of conduits, interest on investment, cleaning out manholes, repairs to and the maintenance of cables, and depreciation of the system, is nearly one cent. per hour over the cost of wires carrying the same current overhead. In the long run, this overcharge will amount to *nil*; it is even questionable whether the difference in cost between the two methods is not already overstated, considering it appears to be an accepted fact that a larger proportion of the electric current reaches its destination through the underground mains than by the overhead line.

**Telephony in Iceland.**—A telephone line, about five miles long, has been established in Iceland. It is regarded as a great curiosity, being the first ever established on the island.

NOTES ON ECONOMY IN CONDUCTORS IN  
SYSTEMS OF DISTRIBUTION OF ELECTRICAL ENERGY.\*

(Concluded from page 714.)

## Variable but Uniform Current Circuits.

If the current in a circuit is not a constant quantity—as in the case of series arc lighting—but variable throughout each day, and from day to day throughout the year, the value previously obtained for the most economical current density to employ refers to the square root of the mean square of the current for the year. In estimating or planning a system of mains it is more convenient to think about the most economical current density referred to the maximum current; that is to say, it is better to know that the greatest economy will be obtained in a given circuit if the current density, when the maximum current is flowing in it, is, say 500 amperes per square inch, than to know that you obtain the most economical arrangement if the current density of the square root of the mean square of the current is, say, 300 amperes per square inch.

It is necessary, then, to consider what the ratio of the maximum current to the square root of the mean square of the current is likely to be in a given circuit; and the best way to arrive at this value is by examination of load diagrams obtained from similar districts.

When Prof. Forbes, in 1885, so strongly advocated the most thorough and careful working out of any system of mains to be laid down in order to obtain the most economical arrangement possible, electrical engineers were necessarily very much in the dark as to the data upon which to base their calculations. It is absolutely essential, in order to plan the most economical arrangement possible, to know beforehand what kind of load diagram you are likely to get. Fortunately, we have now a certain amount of experience to help us, but there is no doubt that in this respect the experience of the next 10 years will be most valuable.

I have worked out one or two load diagrams for a single day in order to give an example. For this diagram, which was taken at Boston, the ratio of the maximum current to the square root of the mean square works out to 2.34, and for this second diagram, which was sent out by a town in the West of England in order that maintenance estimates might be prepared, the ratio is 3.57, and for this third diagram the ratio will be between 2.5 and 3.0.

With a slide rule and planimeter it is, of course, a very easy matter to determine this ratio for any given load diagram. The value to be used, however, is that obtained from a complete set of diagrams taken at short intervals throughout the year, and in connection with this it may be mentioned that Dr. Gustav Rasch states that the value of this ratio (as obtained by observations at different central stations during one year, and taking the average value) is 3.41.

To take an example, let us suppose that the cost of a Board of Trade unit is 3d., that the sum of the rates of interest, depreciation, &c., is 15 per cent., that current flows throughout the year in the circuit under consideration, that the ratio of the maximum current to the square root of the mean square is 3.2, and that the cable is 19-stranded Silvertown L. We have thus

$$b = 3.39$$

$$c = 3$$

$$d = 15$$

$$n = 8,760$$

$$\text{hence } D = 3.2 \times 7,513 \sqrt{\frac{3.39 \times 15}{8,760 \times 3}} = 1,058.$$

In this case, then, the most economical current density is 1,058 amperes to the square inch for the maximum current.

This determination of the most economical current density to employ for a given type of cable applies only to cases in which the current density is uniform throughout the cable under consideration. This is so, of course, in feeders, but not in the mains proper of a system of parallel distribution.

In the latter case the current flowing across any section of the conductor diminishes as the distance of the section under consideration increases from the feeding points. If we assume that in the mains between two pairs of feeding points the current taken off per yard is constant, we can determine a multiplier for the most economical current density, obtained on the assumption that the current is uniform between the feeding points, which will give us what is really the most economical (maximum, or at a section very near the feeding points) current density to employ in the mains.

In the case we have supposed it is easy to see that this multiplier is  $\sqrt{3}$  or 1.732. Now if we take, as before, 19-stranded Silvertown L cable, and make the same assumptions as to the cost of energy, &c., we find that the proper size of main to employ is that which gives us a current density of 1,832 amperes to the square inch at a section very close to the feeding points, and when the maximum current is flowing.

In the case of any other law according to which the current

taken off per yard may vary, it is very easy by constructing, firstly, the curve of flow of current along the main, and secondly, the curve of the squares of the current, to deduce the proper multiplier by means of a planimeter and slide-rule.

The process of making the foregoing calculations for any particular case is certainly easy and very fairly rapid, but it is obvious that before attempting to design a set of mains for a particular district, a thorough canvass should be made to ascertain its special requirements.

It should be remarked that the preceding investigation as to the effect of non-uniformity of current in the mains assumes that the load diagrams for the different buildings supplied between two pairs of feeding points are similar in character, a case which in general does not occur in practice, but for which allowance must be made either in the selection of an average load diagram or subsequently by special calculation.

I may end this portion of these notes by observing that though the current density arrived at may seem sometimes rather great, it occurs for such a very limited time that it is not likely to be harmful to the cables used.

## Transmission of Power to Stationary Motors.

The whole of the foregoing relates to general supply of energy from central stations, and the conclusions arrived at were all based upon the fact that in such work you have to maintain a definite pressure at the consumers, so that the current to be supplied is a fixed quantity.

As is very well known, Sir William Thomson first pointed out in 1881, that in such cases the current density to be employed is independent of the length of conductor through which the energy is to be transmitted, and that the proper gauge to employ for a definite current is that which makes the value of the annual waste of energy per mile equal to the interest, depreciation, &c., on the capital laid out in conductor per mile.

There are, however, a large number of cases to which the above does not apply at all, and the transmission of power from a source where it is cheap to a distant point where it is valuable, is one of the most important of these at present.

In a very important paper read by Profs. Ayrton and Perry before the Society of Telegraph Engineers and Electricians, the authors gave, among other things, the solution of the following problem: What is the most economical current density to employ

when a certain power,  $P$ , has to be furnished at the end of  $\frac{n}{2}$  miles,

and when the pressure at the source has been fixed at  $v$  volts?

If  $c$  is the current in amperes,  $r$  the resistance of the conductor per mile in ohms,  $t$  a constant—depending on the number of hours of working per annum, the cost of the cable per pound of copper, the sum of the rates of interest, depreciation and maintenance, and the value of a Board of Trade unit—and,  $F(c, r)$ , the total waste of energy per mile reckoned in watts (i.e., with the interest, depreciation, &c., on the cable expressed in watts as well as the actual waste of energy in the cable), we have

$$F(c, r) = c^2 r + \frac{t^2}{r} \quad (i.)$$

$$\text{and further, } f(c, r) = P - c(v - ncr) = 0 \quad (ii.)$$

From these two equations we have to determine  $c$  and  $r$ , and hence the current density  $D$ , so that  $F(c, r)$  is a minimum.

As you know, the values of  $c$  and  $r$ , which make  $F(c, r)$  a minimum, are those obtained from the equations

$$\left(\frac{dF}{dc}\right) \cdot \left(\frac{df}{dr}\right) - \left(\frac{dF}{dr}\right) \cdot \left(\frac{df}{dc}\right) = 0 \quad (iii.)$$

$$\text{and } f(c, r) = P - c(v - ncr) = 0 \quad (ii.)$$

From these we obtain

$$c = \frac{P}{v} \frac{nt + \sqrt{(v^2 + n^2 t^2)}}{\sqrt{(v^2 + n^2 t^2)}} \quad (iv.)$$

$$\text{and } D = 23.5 \frac{vt}{1 + \sqrt{(v^2 + n^2 t^2)}} \quad (v.)$$

the constant 23.5 being the conductivity of a copper conductor one mile long of one square inch sectional area.

If we put  $\frac{nt}{v} = \tan \phi$ ,

$$c = \frac{P}{v} (1 + \sin \phi) \quad (vi.)$$

$$\text{and } D = 23.5 \frac{v}{n} \left( \frac{\sin \phi}{1 + \sin \phi} \right) \quad (vii.)$$

I have calculated the following table of values of  $(1 + \sin \phi)$

and  $\left(\frac{\sin \phi}{1 + \sin \phi}\right)$  for values of  $\tan \phi$  between 0.025 and 4.0, thus

embracing all practical cases, I believe. (See Table A.)

From this table, or from the curves given which have been constructed from it, it is a very easy matter to determine the proper current density to employ in any given case without any further calculation than that readily performed with a slide-rule.

With regard to  $t$ , its value is obtained from the equation

$$t = 98.6 \sqrt{\frac{LQ}{NU}}$$

\* Paper read before the Old Student's Association, December 4th, by Hamilton Kilgour, member,

TABLE A.—TRANSMISSION OF POWER.

$\tan \phi.$	$1 + \sin \phi.$	$\frac{\sin \phi}{1 + \sin \phi}.$	$\tan \phi.$	$1 + \sin \phi.$	$\frac{\sin \phi}{1 + \sin \phi}.$	$\tan \phi.$	$1 + \sin \phi.$	$\frac{\sin \phi}{1 + \sin \phi}.$
0	1.0000	0.0000	0.6	1.5145	0.3397	1.8	1.8742	0.4664
0.025	1.0250	0.0244	0.7	1.5734	0.3644	1.9	1.8849	0.4695
0.05	1.0499	0.0471	0.8	1.6246	0.3845	2.0	1.8945	0.4721
0.075	1.0748	0.0696	0.9	1.6689	0.4008	2.2	1.9104	0.4765
0.1	1.0995	0.0905	1.0	1.7072	0.4143	2.4	1.9231	0.4800
0.15	1.1482	0.1291	1.1	1.7402	0.4254	2.6	1.9333	0.4828
0.2	1.1961	0.1640	1.2	1.7680	0.4344	2.8	1.9417	0.4850
0.25	1.2425	0.1952	1.3	1.7924	0.4421	3.0	1.9487	0.4868
0.3	1.2874	0.2232	1.4	1.8137	0.4486	3.3	1.9570	0.4888
0.35	1.3303	0.2483	1.5	1.8319	0.4541	3.6	1.9635	0.4907
0.4	1.3713	0.2708	1.6	1.8482	0.4589	4.0	1.9701	0.4924
0.5	1.4472	0.3090	1.7	1.8619	0.4629	$\infty$	2.0000	0.5000

where  
L = cost in pence in copper in cable per pound.  
N = number of hours in working per annum.  
Q = sum of the rates of interest, depreciation, and main-  
tenance on capital laid out in cable,  
and  
U = cost in pence of a Board of Trade unit.  
If L = cost in £ of copper in cable per ton, the equation becomes

$$t = 30.6 \sqrt{\frac{L \cdot Q}{N \cdot U}}.$$

I have thought it of interest to members that tables and curves showing the effects produced in a particular case of varying the different quantities, t, v, and n, should be given, and I have there-fore taken the following cases :

- (i.) v = 2,000 volts.  
n = 10 miles.  
t variable between 15 and 50.
- (ii.) n = 10.  
t = 25.  
v variable between 500 volts and 10,000 volts.

TRANSMISSION OF POWER.

(i.) P = 87,700 watts. v = 2,000 volts. n = 10 miles.

t.	C.	D.	P <sub>1</sub> .	P <sub>2</sub> .	P <sub>3</sub> .	K.
15	47.13	351.4	6,559	7,619	14,178	7.0
20	48.21	467.9	8,726	10,655	19,382	9.0
25	49.29	582.7	10,878	13,958	24,836	11.0
30	50.35	696.8	13,009	17,542	30,551	12.9
35	51.41	809.8	15,118	21,415	36,533	14.7
40	52.45	921.3	17,199	25,591	42,790	16.4
50	54.48	1,139	21,270	34,892	56,162	19.5

(ii.) n = 10. t = 25.

V.	C.	D.	P <sub>1</sub> .	P <sub>2</sub> .	P <sub>3</sub> .	K.
500	253.8	524.5	39,220	102,681	141,901	30.9
750	153.9	556.6	27,732	53,386	81,118	24.0
1,000	109.0	569.4	21,270	34,892	56,162	19.5
1,500	68.08	579.1	14,418	20,091	34,509	14.1
2,000	49.29	582.7	10,878	13,958	24,836	11.0
3,000	31.66	585.3	7,283	8,602	15,885	7.7
4,000	23.29	586.2	5,471	6,198	11,669	5.9
5,000	18.42	586.7	4,380	4,840	9,220	4.8
7,500	12.08	587.1	2,922	3,123	6,045	3.2
10,000	8.99	587.3	2,192	2,304	4,496	2.4

(iii.) v = 2,000. t = 25.

n.	C.	D.	P <sub>1</sub> .	P <sub>2</sub> .	P <sub>3</sub> .	K.
.25	43.99	587.2	274	276	550	0.3
.5	44.12	587.2	548	555	1,103	0.6
1.0	44.40	587.1	1,096	1,124	2,220	1.2
2.0	44.95	587.0	2,192	2,304	4,496	2.4
4.0	46.04	586.5	4,380	4,840	9,220	4.8
6.0	47.13	585.6	6,559	7,619	14,178	7.0
8.0	48.21	584.3	8,726	10,655	19,381	9.0
10.0	49.29	582.7	10,878	13,958	24,836	11.0
15.0	51.93	577.1	16,162	23,465	39,627	15.6
20.0	54.48	569.7	21,270	34,892	56,162	19.5
25.0	56.93	560.5	26,158	48,397	74,555	23.0
30.0	59.25	549.9	30,794	70,306	101,100	26.0
35.0	61.43	538.0	35,152	82,181	117,333	28.6
40.0	63.46	525.3	39,220	102,680	141,900	30.9
45.0	65.35	511.9	42,996	125,700	168,700	32.8
50.0	67.09	498.0	46,481	151,310	197,790	34.6

- (iii.) v = 2,000 volts.  
t = 25.  
n variable between 1 mile and 50 miles.

And lastly,  
(iv.) v = 5,000 volts.  
t = 25.  
n variable between one mile and 500 miles.

(iv.) v = 5,000 t = 25.

n.	C.	D.	P <sub>1</sub> .	P <sub>2</sub> .	P <sub>3</sub> .	K.
1	17.63	587.4	439	443	881	0.5
2	17.72	587.4	877	895	1,772	1.0
5	17.98	587.2	2,192	2,304	4,496	2.4
10	18.42	587.6	4,380	4,840	9,220	3.7
20	19.29	584.5	8,727	10,655	19,382	9.1
50	21.79	569.8	21,270	34,892	56,162	19.5
100	25.38	525.4	39,220	102,681	141,901	30.9
150	28.06	469.9	52,620	210,480	263,100	37.5
200	29.94	415.4	62,013	361,430	423,440	41.5
250	31.24	467.0	68,481	556,550	625,030	43.9
300	32.13	325.8	72,970	795,990	868,960	45.4
350	32.77	291.4	76,140	1,079,700	1,155,800	46.5
400	33.23	262.7	78,440	1,407,600	1,486,000	47.2
450	33.57	238.6	80,140	1,779,500	1,859,700	47.8
500	33.83	218.2	81,426	2,195,500	2,276,900	48.2

In each case the power to be transmitted, P, has been taken as 87,700 watts, which, with motors of 85 per cent. efficiency, will give 100 brake H.P.

The curves (see pp. 500 and 501) and tables show what changes are produced in the different quantities tabulated—the most economical current density being employed in each case. I should mention that in the curves and tables are included P<sub>1</sub>, P<sub>2</sub>, P<sub>3</sub>, and K where

- P<sub>1</sub> = waste of energy in conductor.
- P<sub>2</sub> = interest, depreciation, &c., on capital laid out in cable.
- P<sub>3</sub> = P<sub>1</sub> + P<sub>2</sub>.
- K = percentage loss of volts in transmission of the power in each case.

You will notice that in cases of transmission of power over a considerable distance, P<sub>1</sub>, the power wasted, bears a pretty high ratio to P, the power transmitted, so that the power of the generators must be considerably in excess of that actually required by the motors.

Now the value of v, and hence of t, depends to a certain extent upon the power of the generators (P + P<sub>1</sub>), and it is not difficult to see that this relation can be expressed by the equation

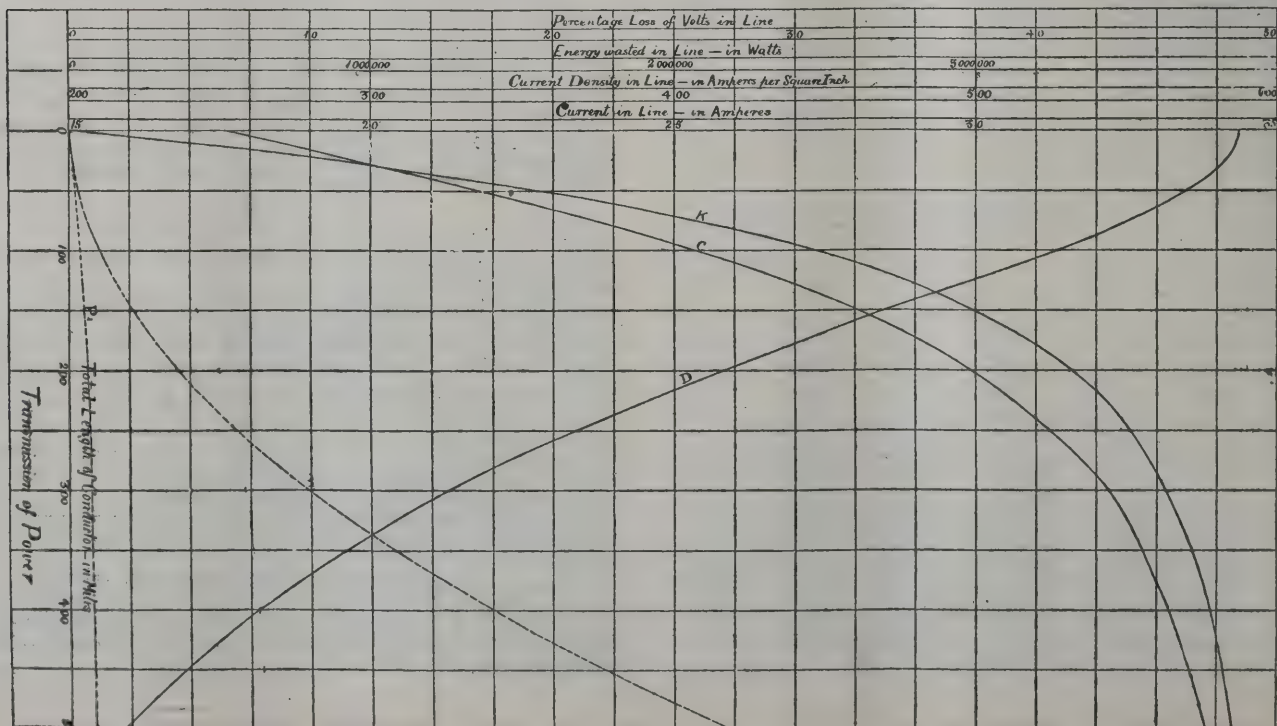
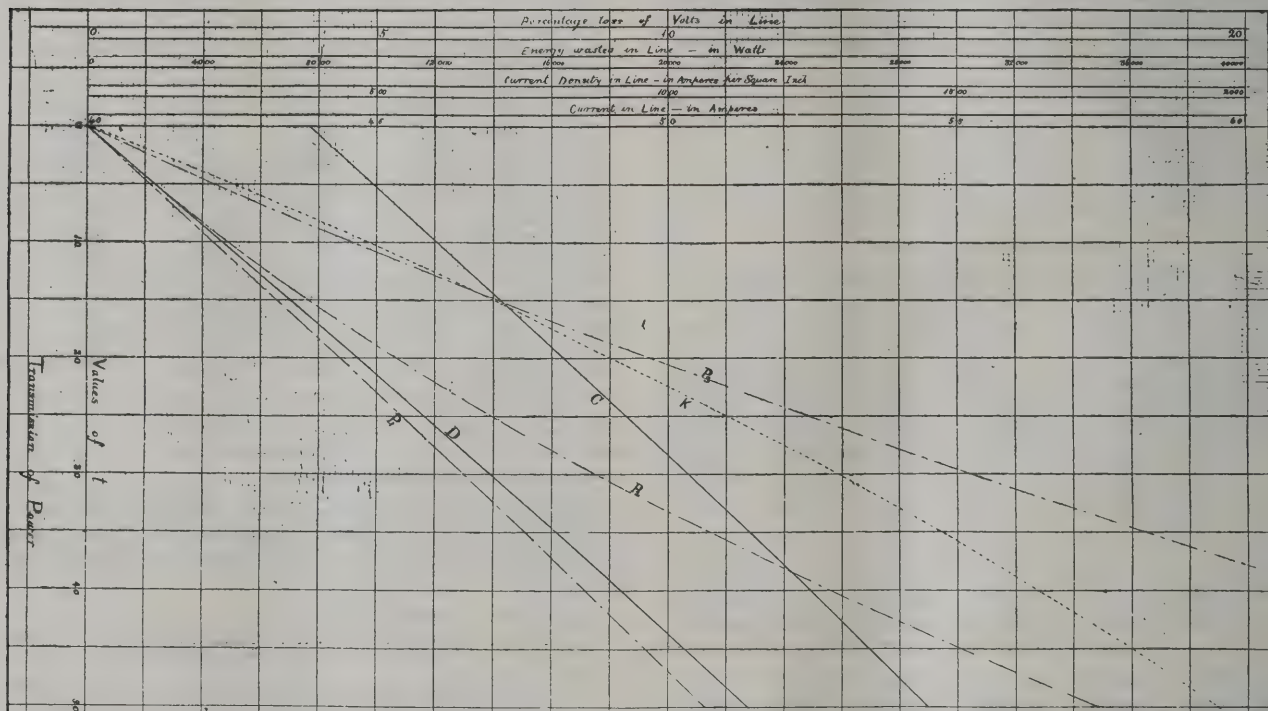
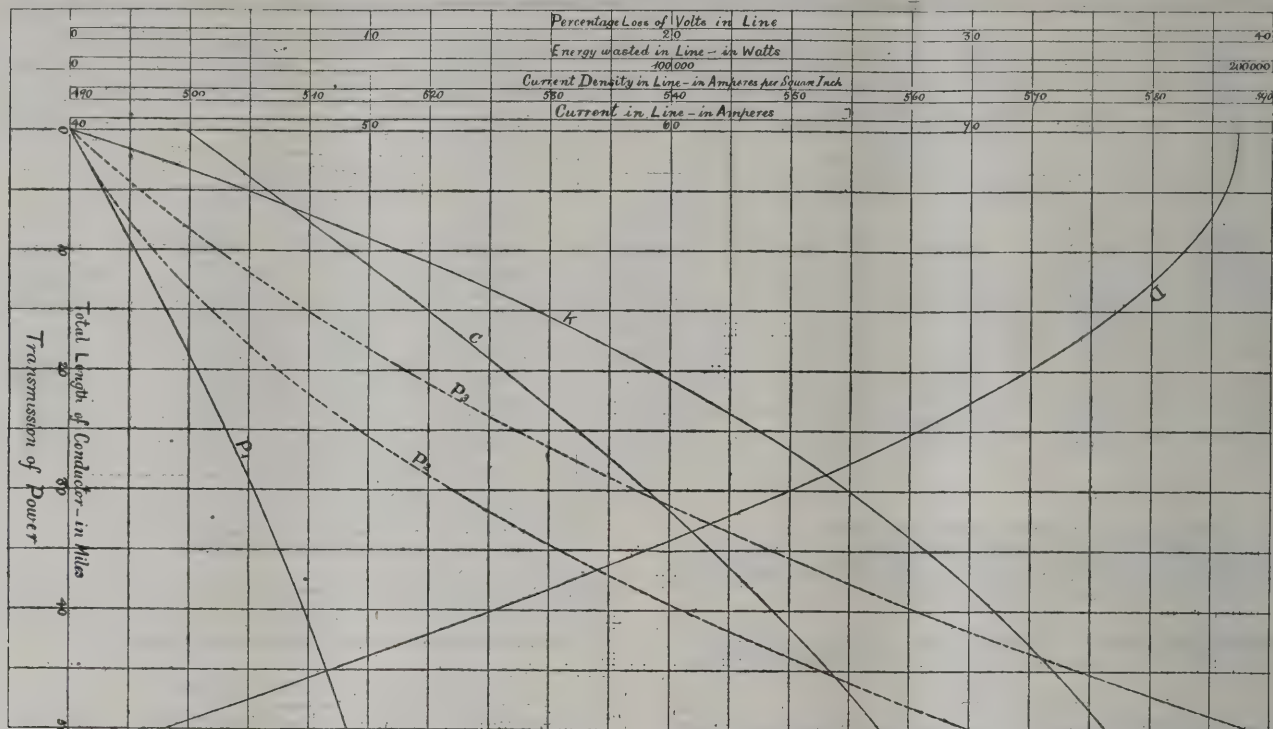
$$t = \sqrt{\frac{P + P_1}{A + B P_1}},$$

where A and B are constants depending on the conditions of the case under consideration.

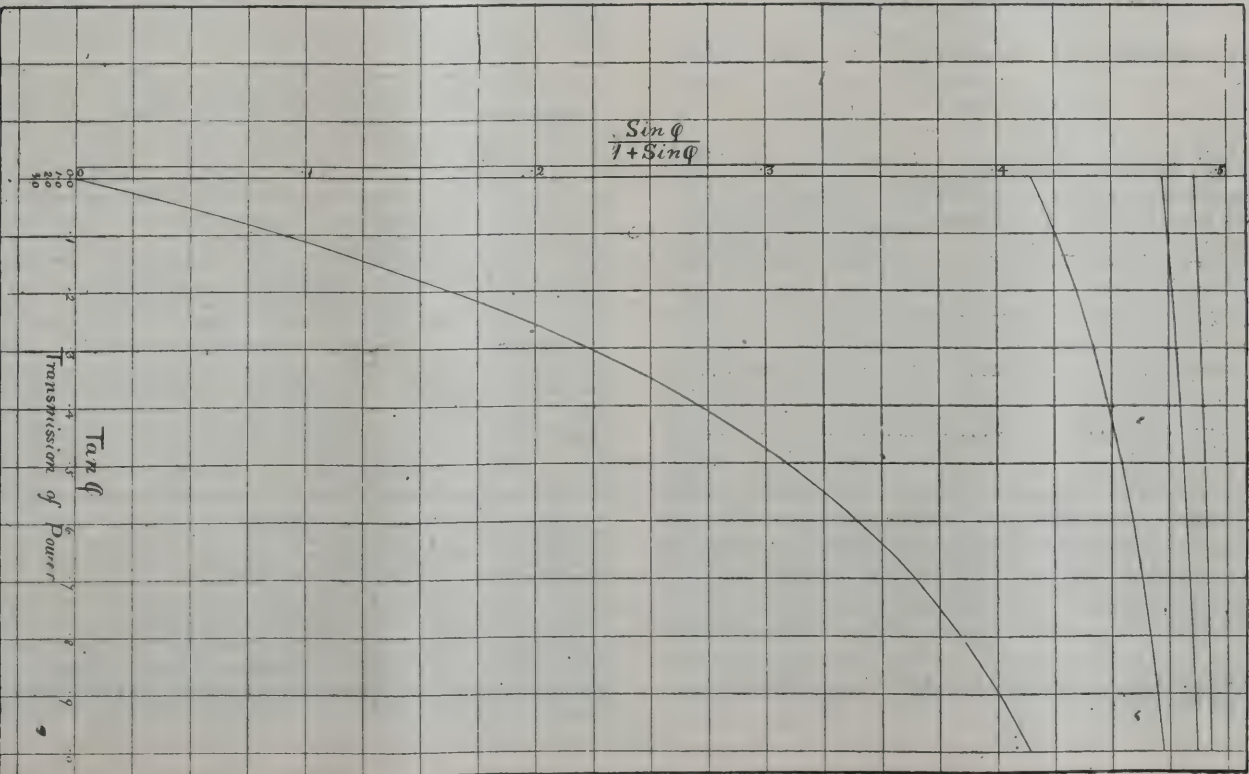
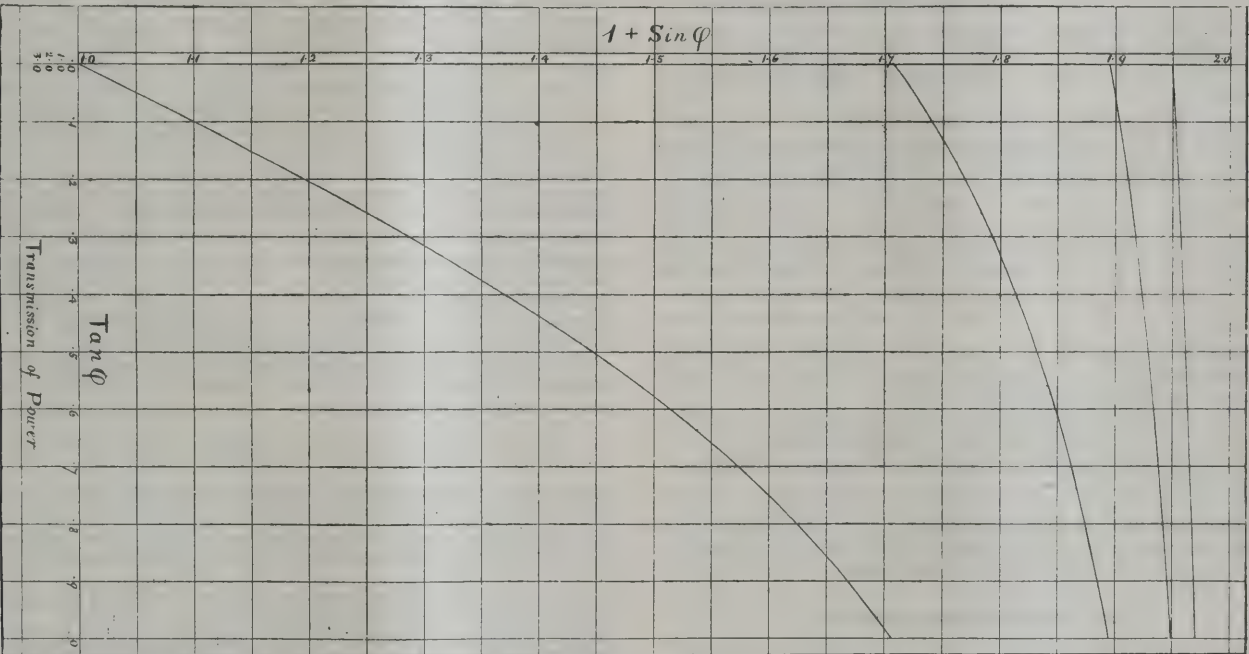
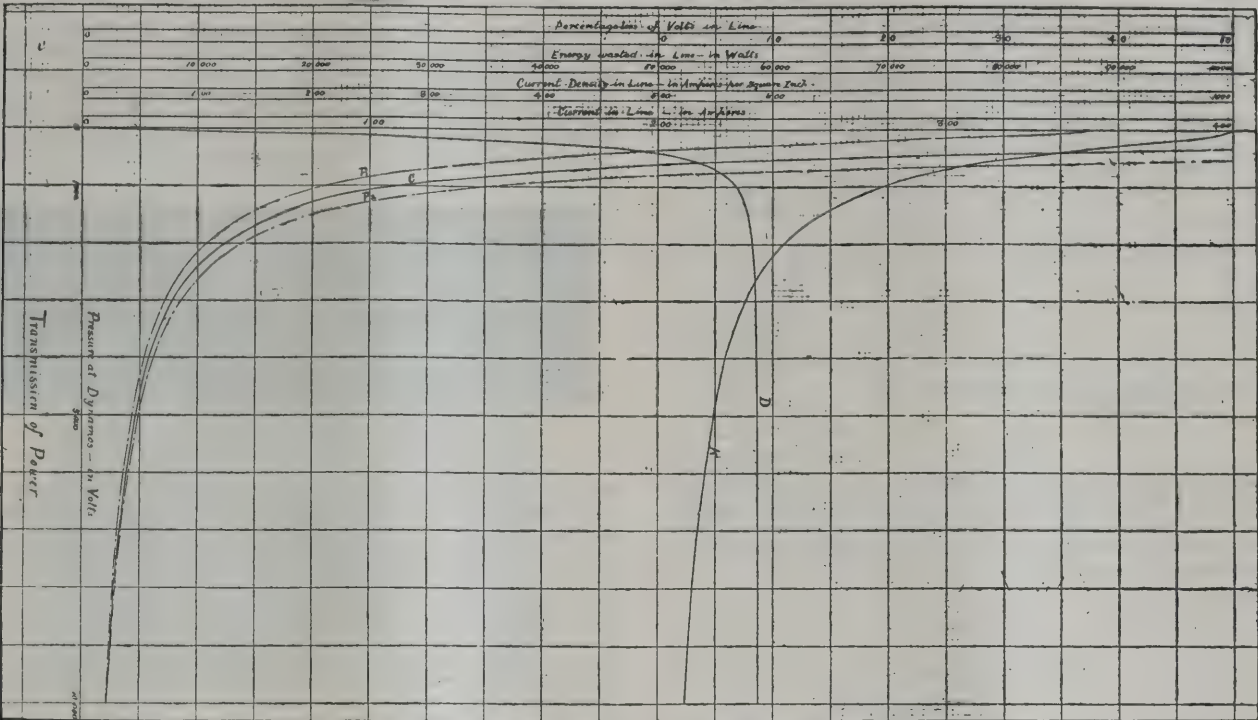
However, from these tables it is easy to judge approximately beforehand what P<sub>1</sub> will be in any given case, so that P + P<sub>1</sub> being known, t can be then accurately estimated, and c and d obtained as before. To take an example, let us suppose that we want to transmit 100 brake H.P. from a waterfall to a mill at a distance of five miles. We will suppose that there is an effective head of 37 feet, that the efficiency of the motors is 85 per cent., that the loss in the line is about 15 per cent., that the generators have an efficiency of 87 per cent., that there is a loss of 5 per cent. in belting, and that we take 2,000 volts as our working pressure.

The power to be transmitted to motors will be 87,700 watts, that developed by the generators 110,000 watts, and that given out by turbines 164 brake H.P.

For the water engines I shall suppose that we use 15-inch Victor turbines, of which the cost, and also that of the accessories, &c., has been kindly furnished me by Mr. Nell, and for the dynamos (motors and generators) I shall take the costs of Victoria machines in this example.



CURVES ACCOMPANYING MR. KILGOUR'S PAPER.



CURVES ACCOMPANYING MR. KILGOUR'S PAPER.

For the case [we] are considering, then, I estimate the costs as under:—

Machinery and line (including posts, insulators, &c., but no cable) ... ..	£2,500
Buildings' foundations, pipes, &c. ... ..	870
Labour (including running of cable) ... ..	750
Sundries ... ..	180

Total ... .. £4,300

Taking then

17½ per cent. on £2,500 ... ..	£437 10 0
12½ " " 870 ... ..	108 15 0
7½ " " 750 ... ..	56 5 0
10 " " 180 ... ..	18 0 0

Total ... .. £620 10 0

Cost of running machinery at both ends, and sundries (say) ... .. 150 0 0

Total ... .. £770 10 0

The total annual expenditure in the production of 110,000 watts is therefore £770 for 2,808 hours (54 hours per week) per annum, or  $v = 0.6d$ ; hence  $t = 26.7$  very approximately if we assume use of bare wire and take copper at 9½d. per pound, and interest, depreciation, &c., on cable at 15 per cent.

Then, since

$$t = 26.7$$

$$v = 2,000$$

$$n = 10,$$

$$\tan \phi_1^* = 0.1335$$

and

$$c = 49.6 \text{ ampères}$$

$$d_1^* = 547 \text{ ampères per square inch.}$$

The necessary conductor would weigh about 10,120 lbs., per mile and cost £390 per mile. In it the loss of power would be about 12 per cent., so that we rather over-estimated it when taking this at 15 per cent.

The following general notes on conductors may be of some use:

Of cables of the same class of insulation, and the same insulation resistance per mile, and the same cross-sectional area, a single wire is the cheapest, and the fewer the number of wires in a strand, the cheaper is the cable. For example, take Silvertown class S, in which the single wires are about 18 per cent. cheaper than the stranded cables of equal cross-sectional area. A concentric cable is generally, as you would expect, considerably dearer than two separate conductors with the same class of insulation and the same insulation resistance per mile between the going and return conductor.

A cylinder of copper of one square inch area and one mile long weighs 20,400 lbs., or 9.1 tons very approximately, and it has a resistance of 0.0425  $\omega$  per mile at 60° F.

Such a cylinder 100 yards long weighs 1,160 lbs., or 0.52 tons, and has a resistance of 0.0024  $\omega$  per mile approximately.

These values apply equally to stranded cables with a high degree of approximation.

With stranded cables the effective area of cross-section and the weight per mile are about 2½ per cent. to 3 per cent. greater, and the resistance per mile is 2½ per cent. to 3 per cent. less than that of a cable composed of the same number of parallel wires.

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 682.)

If, then, we could take a very long magnet, we may utterly neglect the action on the distant pole. If I had a long steel magnet with the south pole 5 or 6 feet away, and the north pole at a point 3 diameters (i.e., 6 centimetres in this case) distant from the mouth of the coil, then the pull of the current in one spiral on the north pole, 3 diameters away, would be practically negligible; it would be less than 2 per cent. of what the pull would be of that single coil when the pole was pushed right up into it. But now, in the case of the tubular coil, consisting of at least a whole layer of turns of wire, the action of all of the turns has to be considered. If the nearest of the turns of wire is at a distance equal to three diameters, all the other turns of wire will be at greater distances, and, therefore, if we may neglect such small quantities as 2 per cent. of the whole amount, we may neglect their action also, for it will be still smaller in amount. Now, for the purpose of arriving at the action of a whole tube of coil, I will adopt a method of plotting devised by Mr. Sayers. Suppose we had a whole tube coiled with copper wire from end to end, its action would be practically the same as though the copper wire were gathered together in small numbers at distant intervals. If, for example, I count the number of turns in a centimetre length of the actual tubular coil which I used in my first experiment, I find there are four. Now if, instead of

having four wires distributed over the centimetre, I had one stout wire in the middle of that space to carry four times the current, the general effect would be the same. This diagram (fig. 60) is calculated out on the supposition that the effect will be not greatly different if the wires were aggregated in that way, and it is easier to calculate. If, beginning at the end of the tube marked A, we take the wires over the first centimetre of

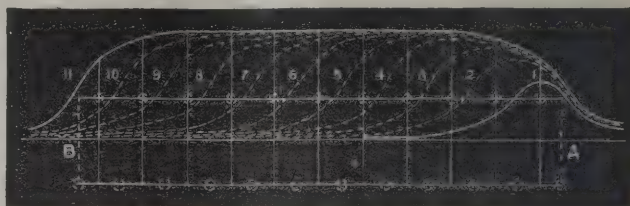


FIG. 60.—ACTION OF TUBULAR COIL.

length and aggregate them, we can draw a curve, marked 1, for the effect of that lot of wires. For the next lot, we could draw a similar curve, but instead of drawing it on the horizontal line we will add the several heights of the second curve on to those of the first, and that gives the curve marked 2; for the third part, add the ordinates of another similar curve, and so gradually build up a final curve for the total action of this tubular coil on a unit pole at different points along the axis. This resultant curve begins about 2½ diameters away from the end, rises gently, and then suddenly, and then turns over and becomes nearly flat with a long level back. It does not rise any more after a point about 2½ diameters along from A; the curve at that point becomes practically flat, or does not vary more than about 1 per cent., however long the tube may be. For example, in a tubular coil 1 inch in diameter and 20 inches long, there will be a uniform magnetic field for about 15 inches along the middle of the coil. In a tubular coil 3 centimetres in diameter and 40 centimetres long, there will be a uniform magnetic field for about 32 centimetres along the middle of the coil. The meaning of this is that the value of the magnetic forces down the axis of that coil begins outside the mouth of the tube, increases, rises to a certain maximum amount a little within the mouth of the tube, and after that is perfectly constant nearly all the way along the tube, and then falls off symmetrically as you get to the other end. The ordinates drawn to the curve represent the forces at corresponding points along the axis of the tube, and may be taken to represent not simply the magnetising force, but the pull on a magnetic pole at the end of an indefinitely long, thin steel magnet of fixed strength.

The rule for calculating the intensity of the magnetic force at any point on the axis of the long tubular coil within this region where the force is uniform, is:—

$$H = \frac{4}{10} \pi \times \text{the ampere-turns per cm. of length.}$$

And, as the total magnetising power of a tubular coil is proportional not only to the intensity of the magnetic force at any point, but also to the length, the integral magnetising effect on a piece of iron that is inserted into the coil may be taken as practically

equal to  $\frac{4}{10} \pi \times$  the total number of ampere-turns in that portion

of the tubular coil which surrounds the iron. If the iron protrudes as much as 3 diameters at both ends, the total magnetising

force is simply  $\frac{4}{10} \pi \times$  the whole number of ampere-turns.

Now that case is, of course, not the one we are usually dealing with. We cannot procure steel magnets with unalterable poles of fixed strength. Even the hardest steel magnet, magnetised so as to give us a permanent pole near, or at the end of it—quite close up to the end of it when you put it into a magnetising coil—becomes by that fact further magnetised. Its pole becomes strengthened as it is drawn in, so that the case of an unalterable pole is not one which can actually be realised. One does not usually work with steel: one works with soft iron plungers, which are not magnetised at all when at a distance away, but become magnetised in the act of being placed at the mouth of the coil, and which become more highly magnetised the further they go in. They tend, indeed, to settle down, with the ends protruding equally, for that is the position where they most nearly complete the magnetic circuit; where, therefore, they are most completely and highly magnetised. Accordingly, we have this fact to deal with, that whatever may be the magnetising forces all along a tube, the magnetism of the entering core will increase as it goes on. We must therefore have recourse to the following procedure. We will construct a curve in which we will plot, not simply the magnetising forces of the spiral at different points, but the product of the magnetising forces into the magnetism of the core which itself increases as the core moves in. The curve with a flat top to it corresponds to an ideal case of a single pole of constant strength. We wish to pass from this to a curve which shall represent a real case, with an iron core. Let us still suppose that we are using a very long core, one so long, that when the front pole has entered the coil, the other end is still a long way off. With an iron core, of course, it depends on the size and quality of the iron as to how much magnetism you get for a given amount of magnetising power. When the core has entered up to a certain

\* Cantor Lecture. Delivered before the Society of Arts, February 3rd, 1890.

point, you have all the magnetising forces up to that point acting on it: it acquires a certain amount of magnetism, so that the pull will necessarily go on increasing and increasing, although the intensity of the magnetic force from point to point along the axis of the coil remains the same, until within about two diameters from the far end. Although the magnetic force inside the long spiral remains the same, because the magnetism of the core is increasing, the pull goes on increasing and increasing (if the iron does not get saturated) at an almost uniform rate all the way up, until the piece of iron has been poked pretty nearly through to the distant end. In fig. 61, a tubular coil, B A, is represented. Sup-

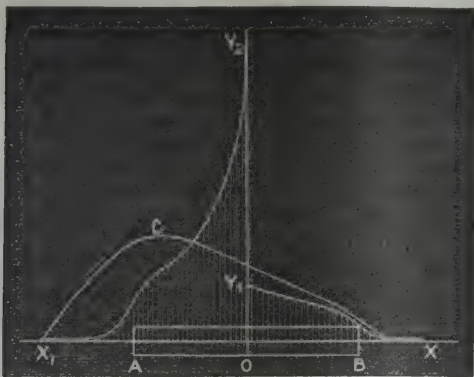


FIG. 61.—DIAGRAM OF FORCE AND WORK OF COIL AND PLUNGER.

pose a long iron core is placed on the axis to the right, and that its end is gradually brought up toward B. When it arrives at x, the pull becomes sensible, and increases at first rapidly, as the core enters the mouth of the tube, then gently, as the core travels along, attaining a maximum, c, about at the further end, A, of the tube. When it approaches to the other end, A, it comes to the region where the magnetising force falls off, but the magnetism is still going on increasing, because something is still being added to the total magnetising power, and these two effects nearly balance one another, so that the pull arrives at the maximum. This is the highest point, c, on the curve; the greatest pull occurring just as the end of the iron core arrives at the bottom or far end of the tubular coil: from which point there is a very rapid falling off. The question of rapidity of descent from that point depends only on how long the core is. If the core is a very long one, so that its other pole is still very far away, you have a long, slow descent going on over some three diameters, and gradually vanishing. If, however, the other pole is coming up within measurable distance of B, then the curve will come down more rapidly to a definite point, x<sub>1</sub>. To take a simple case where the iron core is twice as long as the coil, its curve will descend in pretty nearly a straight line down to a point such that the ends of the iron rod stand out equally from the ends of the tube.

Precisely similar effects will occur in all other cases where the plunger is considerably longer than (at least twice as long as) the coil surrounding it. If you take a different case, however, you will get another effect. Take the case of a plunger of the same length as the coil, then this is what necessarily happens. At first the effects are much the same; but as soon as the core has entered about half, or a little more than half its length, you begin to have the action of the other pole that is left protruding outside tending to pull the plunger back; and although the magnetising force goes on increasing the further the plunger enters, the repulsion exerted by the coil on the other pole of the plunger keeps increasing still faster as this end nears the mouth of the coil. In that case the maximum will occur at a point a little further than half way along the coil, and from that point the curve will descend and go to zero at A; that is to say, there will be no pull when both ends of the plunger coincide with the two ends of the coil. If you take a plunger that is a little shorter than the coil, then you find that the attraction comes down to zero at an earlier period still. The maximum pull occurs earlier, and so does the reduction of the pull to zero; there being no action at all upon the short core when it lies wholly within that region of the tube within which the intensity of the magnetic force is uniform. That is to say, for any portion of this tube corresponding to the flat top of the curve of Fig 60, if the plunger of iron is so short as to lie wholly within that region, then there is no action upon it; it is not pulled either way. Now these things can be not only predicted by the help of such a law as that, but verified by experiment. Here is a set of tubular coils which we use at the Finsbury Technical College for the purpose of verifying these laws. There is one here about nine inches long, one about half that length, another just a quarter. They are all made alike in this way, that they have exactly the same weight of copper wire, cut from the same hank, upon them. There are, of course, more turns on the long one than on the shorter, because with the shorter ones each turn requires on the average a larger amount of wire, and therefore the same weight of wire will not make the same number of windings. We use that very simple apparatus, a Salter's balance, to measure the pull exerted down to different distances on cores of various lengths. You find in every case the pull increases and becomes a maximum, then diminishes. We will now make the experiment, taking first a long plunger, roughly about twice as long as the coil. The

pull increases as the plunger goes down, and the maximum pull occurs just when the lower end gets to the bottom; beyond that the pull is less. Using the same plunger, with these shorter coils, one finds the same thing, in fact more marked, for we have now a core which is more than twice the length of the coil. So we find, taking in all these cases, that the maximum pull occurs, not when the plunger is half way in, as the books say, but when the bottom end of it is just beginning to come out through the bottom of the coil that we are using. If, however, we take a shorter plunger, the result is different. Here is one just the same length as the coil. With this one the maximum pull does occur when the core is about half way in; the maximum pull is just about at the middle. Again, with a very short core—here is one about one-sixth of the length of the coil—the maximum pull occurs as it is going into the mouth of the coil; and, when both ends have gone in so far that it gets into the region of equable magnetic field there is no more pull on one end than on the other; one end is trying to move with a certain force down the tube, and the other end is trying to move with exactly equal force up the tube, and the two balance one another. If we carry that to a still more extreme case, and employ a little round ball of iron to explore down the tube, you will find this curious result, that the only place where any pull occurs on the ball is just as it is going in at the mouth. For about half an inch in the neck of the coil there is a pull; but there is no pull down the interior of the tube at all, and there is no measurable pull outside.

Now these actions of the coil on the core are capable of being viewed from another standpoint. Every engineer knows that the work done by a force has to be measured by multiplying together the force and the distance through which its point of application moves forward. Here we have a varying force acting over a certain range. We ought, therefore, to take the amount of the force at each point, and multiply that by the adjacent little bit of range, averaging the force over that range, and then take the next value of force with the next little bit of range, and so consider in small portions the work done along the whole length of travel. If we call the length of travel  $x$ , the element of length must be called  $d, x$ . Multiply that by  $f$ , the force. The force multiplied by the element of length, gives us the work  $d, w$ , done in that short range. Now the whole work over the whole travel is made up of the sum of such elements all added together; that is to say, we have to take all the various values of  $f$ , multiply each by its

own short range  $d, x$ , and the sum of all those, writing  $\int$  for the

sum, would be equal to the sum of all the work; that is to say, the whole work done in putting the thing together will be written:

$$w = \int f d x.$$

Now, what I want you to think about is this: Here, say, is a coil, and there is a distant core. Though there is a current in the coil it is so far away from the core that practically there is no action; bring them nearer and nearer together; presently they begin to act on one another, there is a pull, which increases as the core enters, then comes to a maximum, then dies away as the end of core begins to protrude at the other side. There is no further pull at all when the two ends stand out equally. Now there has been a certain total amount of work done by this apparatus. Every engineer knows that if we can ascertain the force at every point along the line of travel the work done in that travel is readily expressed by the area of the force curve. Think of the curve,  $x, c, x$ , in fig. 61, the ordinates of which represent the forces. The whole area underneath this curve represents the work done by the system, and therefore represents equally the work you would have to do upon it in pulling the system apart. The area under the curve represents the total work done in attracting in the iron plunger, with a pull distributed over the range  $x, x_1$ .

Now I want you to compare that with the case of an electro-magnet where, instead of having this distributed pull, you have a much stronger pull over a much shorter range. I have endeavoured to contrast the two in the other curves drawn in fig. 61. Suppose we have our coil, and suppose the core, instead of being made of one rod such as this, were made in two parts, so that they could be put together with a screw in the middle, or fastened together in any other mechanical way. Now first treat this rod as a single plunger, screw the two parts together, and begin with the operation of allowing it to enter into the coil, the work done will be the area under the curve which we have already considered. Let us divide the iron core into two. First of all put in one end of it; it will be attracted up in a precisely similar fashion, only being a shorter bar, the maximum would be a little displaced. Let it be drawn in up to half way only; we have now a tube half filled with iron, and in doing so we shall have had a certain amount of work done by the apparatus. As the piece of iron is shorter, the force-curve, which ascends from  $x$  to  $x_1$ , will lie little lower than the curve,  $x, c, x_1$ ; but the area under that lower curve, which stops half way, will be the work done by the attraction of this half core. Now go to the other end and put in the other half of the iron. You now have not only the attraction of the tube, but that of the piece which is already in place, acting like an electro-magnet. Beginning with a gentle attraction, it soon runs up, and draws the force-curve to a tremendously steep peak, becoming a very great force when the distance asunder is very small. We have therefore in this case a totally different curve made up of two parts, a part for the putting in of the first half of the core, and a steeper part for the second; but the net result is, we have the same quantity of iron magnetised in exactly the same manner by the same quantity of electric current running round

the same amount of copper wire—that is to say, the total amount of work done in these two cases is necessarily equal. Whether you allow the entire plunger to come in by a gentle pull over a long range, or whether you put the core in in two pieces—one part with a gentle pull, and the other with a sudden spring up at the end—the total work must be the same; that is to say, the total area under our two new curves must be the same as the area under the old curve. The advantage, then, of this coil-and-plunger method of employing iron and copper is, not that it gets any more work out of the same expenditure of energy, but that it distributes the pull over a considerable range. It does not, however, equalise it altogether over the range of travel.

A number of experimental researches have been made from time to time to elucidate the working of the coil and plunger. Hankel, in 1850, examined the relation between the pull in a given portion of the plunger and the exciting power. He found that, so long as the iron core was so thick and the exciting power so small that magnetisation of the iron never approached saturation, the pull was proportional to the square of the current, and was also proportional to the square of the number of turns of wire. Putting these two facts together we get the rule—which is true only for an unsaturated core in a given position—that the pull is proportional to the square of the ampère turns. This might have been expected, for the magnetism of the iron core will, under the assumptions made above, be proportional to the ampère turns, and the intensity of the magnetic field in which it is placed being also proportional to the ampère turns, the pull, which is the product of the magnetism and of the intensity of the field, ought to be proportional to the square of the ampère turns.

Dub, who examined cores of different thicknesses, found the attraction to vary as the square root of the diameter of the core. His own experiments show that this is inexact, and that the force is quite as nearly proportional to the diameter as to its square root. There is again reason for this. The magnetic circuit consists largely of air-paths by which the magnetic lines flow from one end to the other. As the main part of the magnetic reluctance of the circuit is that of the air, anything which reduces the air reluctance increases the magnetisation, and, consequently, the pull. Now, in this case, the reluctance of the air-paths is mainly governed by the surface exposed by the end portions of the iron core. Increasing these diminishes the reluctance, and increases the magnetisation by a corresponding amount. Von Waltenhofen, in 1870, compared the attraction exerted by two equal (short) tubular coils on two iron cores, one of which was a solid cylindrical rod, and the other a tube of equal length and weight, and found the tube to be more powerfully attracted. Doubtless, the effect of the increased surface in diminishing the reluctance of the magnetic circuit explains the cause of the observation.

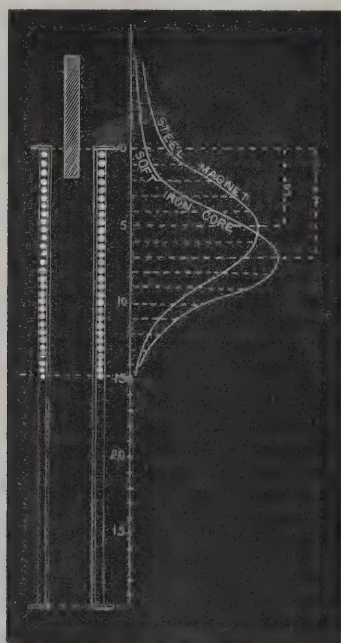


FIG. 62.—VON FEILITZSCH'S EXPERIMENT ON PLUNGERS OF IRON AND STEEL

Von Feilitzsch compared the action of a tubular coil upon a plunger of soft iron with that exerted by the same coil upon a core of hard magnetised steel of equal dimensions. The plungers, fig. 62, were each 10·1 centimetres long; the coil being 29·5 centimetres in length, and 4·2 in diameter. The steel magnet showed a maximum attraction when it had plunged to a depth of 5 centimetres, whilst the iron core had its maximum at a depth of 7 centimetres, doubtless because its own magnetisation went on increasing more than did that of the steel core. As the uniform field region began at a depth of about 8 centimetres, and the cores were 10·1 centimetres in length, one would expect the attracting force to come to zero when the cores had plunged into a depth of about 18 centimetres. As a matter of fact, the zero point was reached a little earlier. It will be noticed that the

pull at the maximum was a little greater in the case of the iron plunger.

The most careful researches of late years are those made by Dr. Theodore Bruger, in 1886. One of his researches, in which a cylindrical iron plunger was used, is represented by two of the curves in fig. 63. He used two coils, one 3½ centimetres long, the other 7 centimetres long. These are indicated in the bottom left-hand corner. The exciting current was a little over 8 ampères.

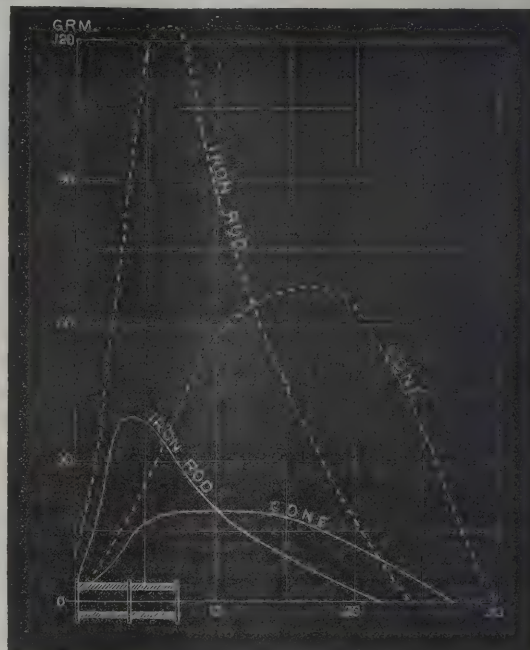


FIG. 63.—BRUGER'S EXPERIMENTS ON COILS AND PLUNGERS.

The cylindrical plunger was 39 centimetres long. The plunger is supposed, in the diagram, to enter on the left, and the number of grammes of pull is plotted out opposite the position of the entering end of the plunger. As the two curves show by their steep peaks

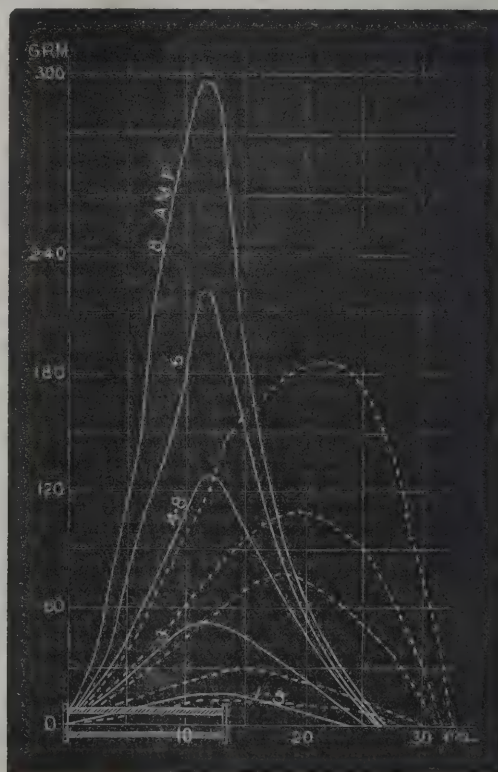


FIG. 64.—BRUGER'S EXPERIMENTS, USING CURRENTS OF VARIOUS STRENGTH.

the maximum pull occurs just when the end of the plunger begins to emerge through the coil: and the pull comes down to zero when the ends of the core protrude equally. In this figure the dotted curves relate to the use of the longer of the two coils. The height of the peak, with the coil of double length, is nearly four times as great, there being double ampère-turns of excitation. In some other experiments, which are plotted in fig. 64, the same core was used with a tubular coil 13 centimetres long. Using currents of various strengths, 1·5 ampère, 3, 4·8, 6, or 8 ampères,

the pull is of course different, but, broadly, you get the same effect, that the maximum pull occurs just where the pole begins to come out at the far end of the tubular coil. There are slight differences; with the smallest amount of current the maximum is exactly over the end of the tube, but with currents rather larger, the maximum point comes a little farther back. When the core gets well saturated, the force curve does not go on rising so far; it begins to turn over at an earlier stage, and the maximum place is necessarily displaced a little way back from the end of the tube. That was also observed by Von Waltenhofen when using the steel magnet.

(To be continued.)

## LONDON COUNTY COUNCIL.

THE weekly meeting was held on Tuesday at Spring Gardens, S.W., Sir John Lubbock in the chair. The Highways Committee reported the following:

The council on the 30th of September last sanctioned the continued employment for three months in the engineer's department of a person, at a salary of £3 3s. a week, who has been since 25th February last assisting with the work connected with the business of which your committee has charge. The time referred to has now elapsed; but the chief engineer has informed us that the assistance it still required. We propose to report again on this matter after the Christmas vacation; and in the meantime we recommend: That the services of the temporary assistant now employed at a salary of £3 3s. a week in the engineer's department, be retained until the second meeting of the council in January next.

We have considered a letter from the London Electric Supply Corporation, asking that in the case of the service lines from distributing mains the one month's notice specified in the company's order may not be insisted upon, and that a shorter notice may be accepted. The company states that the Postmaster-General has agreed to accept a 48 hours' notice, and asks that the council will do the same. We are of opinion that, although in the case of the laying of service lines, the one month's notice is not necessary, the 48 hours' notice proposed by the company is on the other hand insufficient, and that at least four days' notice should be given by the company. We therefore recommend:—

That the London Electric Supply Corporation be informed with reference to the laying of service lines from distributing mains already laid, that the council will, until it gives notice to the contrary, accept four days' notice, instead of the one month's notice, required by the company's order.

We have considered a notice (Registered No. 139), dated 5th December, 1890, from the vestry of St. Pancras, of electric lighting works proposed to be carried out by the vestry in certain streets in the parish, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883, as shown upon three plans and six drawings submitted with the application. The details shown are generally satisfactory, but if any high tension mains are to be used, some precautions appear to be necessary for the prevention of accidents. We recommend—

That the council do approve the works referred to in the notice (Registered No. 139), of the vestry of St. Pancras, dated 5th December, 1890, under the provisions of the St. Pancras (Middlesex) Electric Lighting Order, 1883; and that it be suggested to the vestry that where any high tension mains are used the frames and the cover of the boxes through which the mains pass should be carefully earthed.

The Kensington and Knightsbridge Electric Lighting Company has given a notice (Registered No. 140), dated 27th November, 1890, of a proposed extension of mains in Alfred Place West (1 plan). The works are of the usual description; and we recommend—

That the consent of the council be given to the works referred to in the notice (Registered No. 140) of the Kensington and Knightsbridge Electric Lighting Company, Dated 27th November, 1890.

A notice, dated 2nd December, 1890 (Registered No. 141), has been given by the Metropolitan Electric Lighting Company of intention to lay mains in Northumberland Avenue, from the Hotel Victoria to Whitehall, and thence along Whitehall and Whitehall Place to the company's station in Whitehall Court (1 plan). These works are of the same description as those of this company already sanctioned; and although there is a subway in Northumberland Avenue, we think it unnecessary that the company should be required to lay in the subway the very short length of main for that thoroughfare included in the notice. We recommend:—

That the sanction of the council be given to the works referred to in the notice (Registered No. 141), dated 2nd December, 1890, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works; that the mains be enclosed in 5-inch iron pipe and be laid under the footways wherever it is found practicable to do so; that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving; and that the works generally shall be of the character approved by the council on 1st October, 1889.

The London Electric Supply Corporation has served three notices (Registered Nos. 142, 143 and 144), one dated 25th November, and two 2nd December, 1890, under section 19 of the com-

pany's order of 1889, of works executed on emergency, in laying service lines to No. 15, Clifford Street, Bond Street, and to Nos. 14 and 42, Curzon Street. There is no reason for objecting to these works; and we report for the information of the council the receipt of the notices with regard to them.

## ELECTRIC LIGHTING PROGRESS IN LONDON.\*

By F. BAILEY, Assoc. M. Inst. C.E.

THE last paper on electric lighting read before the Society was by Mr. R. E. B. Crompton, in 1888, when he placed before you some of the difficulties and obstacles which were retarding the progress of electric lighting. The rapid progress made within the last 18 months will, however, show that these difficulties have, to a great extent, been removed by a number of supply companies having obtained Parliamentary powers to lay mains within certain specified areas into which London has been divided. I propose, therefore, to place before you, in general terms, the work done and in progress by the various companies, as the time at my disposal will not permit me to give minute details of generating stations and systems.

Through the kindness of Mr. J. W. Swan, I have the honour to show you the first lamp he made. It is to be hoped that this lamp will eventually come under the care of one of our great museums, in order that future ages may recognise the genius of Mr. Swan.

I have also to thank Mr. Sydney Morse for the loan of another valuable historical lamp, this being the first lamp constructed by Edison.

Turning to the record of general distribution of the electric light in London, you all know that practically nothing was done under the Act of 1882, but private enterprise provided fields for encouraging the efforts of the electrical engineer, and foremost amongst these must be mentioned the Grosvenor Gallery station, which did such good service in making the capabilities of the light known, and in proving the absolute necessity that existed for it; for however defective the supply may have been towards the close of the existence of the station (owing to the plant being overloaded), we owe a debt of gratitude to Lord Crawford for his energetic support to this enterprise, and to those who worked so hard to bring it to perfection. Mr. Ferranti, and those who worked with him at the Grosvenor, laid the foundation stone of a satisfactory transformer system, and as they had no Parliamentary powers to lay down underground mains, overhead lines were run in all directions. The perfection to which they brought the details of overhead construction is so fully proved by the absence of accidents, that it is much to be regretted that the overhead conductors in the United States were allowed to have been put up with no regard to common sense or safety.

It is frequently stated that the Electric Lighting Act of 1882 did much towards stifling inordinate speculation, but in attempting to make people wise by this Act of Parliament, a very serious check was placed upon the development of electrical progress.

The enormous strides which have been made under the more encouraging Electric Lighting Act of 1888 will convince everyone that it was urgently required, and electrical engineers fully realise what they owe to Sir Frederick Bramwell for his share in framing this Act. One of the consequences of this Act was a deluge of applications for provisional orders. A court of enquiry was therefore ordered by the Board of Trade, who appointed Major Marindin as their inspector for this purpose.

If you carefully read the 18 days' evidence given, you will probably be convinced that every system was the best. The inquiry lasted several days, and resulted in the granting of provisional orders, confirmed by Parliament in August, 1889, to the companies mentioned in the summary on page 54, which also includes other information.

I must here gratefully acknowledge the very cordial assistance which the engineers of the various companies have given me.

We will now very briefly go round the stations of the companies, commencing with

### *The Kensington and Knightsbridge Electric Light Company.*

This company commenced work under the name of the Kensington Court Electric Light Company in the autumn of 1886, and under Mr. Crompton's able guidance made such rapid progress that they commenced to supply current in January, 1887, using underground mains and running their plant in a temporary building. The Board of Trade license under which the work commenced, is incorporated in the company's provisional order of 1889, which authorises them to supply a portion of the parish of Kensington, St. Mary Abbot, and the detached portion of the parish of St. Margaret, Westminster.

The direct current is employed in conjunction with "Howell" secondary batteries, the pressure being 200 volts on the 3-wire system, with 100 volts in the houses.

The satisfactory use of secondary batteries in this manner has attained its present development mainly through the indefatigable labours of Mr. J. C. Howell.

Two generating stations are erected, one at Kensington Court, and the other at Chapel Place, Knightsbridge, the plant consisting of "Babcock and Wilcox" boilers and exhaust steam feed

\* Read before the Society of Arts, Wednesday, December 10th.

water heaters, "Willans's" compound engines combined direct with Crompton dynamos and "Howell" batteries in both stations. There is also a battery station situated near the centre of the Kensington district at Queen's Terrace Mews, where two large "Howell" batteries are placed. In all cases ample space is provided for the future extension of the plant when required. Arrangements are provided on the Kensington Court station switchboards to enable any dynamo to be used for charging the distant battery station, to which a pair of charging mains are laid, Mr. Crompton also designed for this company a system of mains of considerable novelty, which was severely criticised at the time, but has since proved most satisfactory.

Culverts constructed with concrete or brickwork are laid under the pavements, and bare copper conductors, supported at intervals by glass insulators, are placed in these culverts. The conductors are composed of copper strips  $1\frac{1}{2}$  by  $\frac{1}{4}$  inch, laid one over the other, so as to make up the total section required. In cases where there is no room under the pavement in which to build up the culvert, wrought-iron gas tubing is used, and cables insulated with thick vulcanised rubber are drawn through and connected to the bare conductors. Numerous service boxes are fixed in the pavements to enable houses to be connected without opening the ground. Four and a half miles of pipes with cables have been laid.

On the 1st December, lamps were connected to an equivalent of 24,850 32-watt lamps, and Mr. H. W. Miller, the company's engineer, to whom I am indebted for these particulars, informs me that the lamp supply, or maximum number of lamps in use at one moment, is between 30-40 per cent. of the lamp connection.

#### *The House-to-House Electric Light Supply Company.*

This company covers a large area, which consists of two detached districts, practically North Kensington and West Brompton. The generating station is situated off the Richmond Road, West Brompton, and contains space for a very large plant.

The Lowrie-Hall alternating current transformer system is adopted, with 2,000 volts on the mains. Four principal mains at present carry the current from the station, the transformers being connected to these mains where required. Cast-iron pipes are laid to form a conduit into which vulcanised india-rubber "Silver-town" cables are drawn; suitable manholes, covers, and junction-boxes being provided.

At present the demand for light is supplied from a plant, consisting of:—

Three "Babcock and Wilcox" boilers, working at 150 lbs. per square inch.

Three "Fowler" compound horizontal engines, each of 200 indicated horse-power.

Three "Lowrie-Hall" alternators, each of 100 units 2,000 volts.

Three "Elwell-Parker" exciters, each of 3 units.

The engines work at a speed of 88 revolutions per minute, each engine driving one alternator by seven cotton ropes, the exciter for each alternator being driven by cotton ropes from the alternator pulley.

The Lowrie-Hall pressure regulator and recording instruments are also used. Mr. Hall, the company's manager, has kindly given me this information, and states that on their lamp connections, equivalent to 12,898 lamps of 8 candle-power, the maximum lamp supply is equivalent to 5,430 lamps of 8 candle-power—say, 42 per cent.

#### *St. James and Pall Mall Electric Lighting Company.*

This company was formed for the purpose of supplying the whole of the parish of St. James's, Westminster, and commenced to supply current under their provisional orders from their station in Mason's Yard, Duke Street, on April 4th, 1889.

The direct current is employed without batteries. At present the above station supplies the southern half of the district, the total plant consisting of:—

Five "Davey-Paxman" boilers, working at 150 lbs. per square inch.

Two large Berryman feed water heaters.

Ten Willans's compound engines, each of 200 indicated horse-power.

Two Willans's compound engines, each of 80 indicated horse-power.

Twelve dynamos, "Latimer Clark, Muirhead & Co.," and "Siemens," driven direct from the engines.

The whole of this plant is neatly arranged, so as to occupy the least space.

The mains consist of a network of conductors on the three-wire system, supplied at about 100 volts at the station by suitable feeders. A cast iron trough or culvert is laid under the surface of the pavement, and three conductors, each consisting of a number of strips of bare copper, which can be added to at any time, are carried by porcelain bridges, placed at suitable intervals apart. To avoid any risk of the mains touching each other, porcelain distance pieces are placed over the mains. A cast iron lid, with water-tight joint, covers the trough. Connection to customers' houses is made by drawing well-insulated cable through gas tubing, which is screwed into the trough.

On the 5th December, a total, equivalent to 23,174 lamps of 8 candle-power, were connected. Mr. Dolson, the company's engineer, kindly informed me that the maximum lamp supply is equal to about 13,222 lamps of 8 candle-power—say 57 per cent.

#### *The Westminster Electric Supply Corporation, Limited.*

The district in which this corporation is authorised to supply electricity by its provisional order comprises that portion of the united parishes of St. Margaret and St. John, Westminster, which lies to the south of the centre line of the Metropolitan District Railway, and the portion of the St. George, Hanover Square, covering Belgravia and Mayfair.

The system adopted is similar to that of the Kensington and Knightsbridge Company, direct current in conjunction with batteries used as regulators, and also for supply during hours of minimum demand.

Three stations are being erected, one at Millbank Street, one at Eccleston Place, and one in Davies Street.

Current is now being supplied from the Millbank Street station and from a small temporary station in Dacre Street. The other two are being pushed forward as fast as possible, in order to supply from all stations early in the year.

Mains are being laid for a three-wire distribution, Messrs. Crompton being the contractors for the Westminster district, where the system adopted is similar to that put down by Mr. Crompton for the Kensington and Knightsbridge Company.

For other parts of the district Prof. Kennedy, the engineer to the company, has devised the following arrangement: bare copper strip rests on stoneware insulators placed from 6 to 8 feet apart, and bedded in the concrete culvert. The copper is stretched by a special tool before being pulled in, and this process gives it sufficient stiffness not to sag perceptibly between the insulators. The total sectional area of the conductors can be increased when required by the addition of more copper strip. Feeders are used in a most systematic manner, and Prof. Kennedy is to be congratulated on the favourable prospects of this company's work. There is a large demand for light in the district, and the rapid progress of this company justified the expectation of a speedy supply from the stations now in progress.

#### *The London Electric Supply Corporation, Limited.*

The Parliamentary powers possessed by this company cover a large area, comprising the district bordering the south side of the Thames from Westminster Bridge to Greenwich, Mayfair, Belgravia, St. James's and Pall Mall, St. Martin's-in-the-Fields, part of Westminster, Chelsea, and two isolated areas, namely, Newington and Clerkenwell.

The Ferranti system is employed throughout, alternating current being generated at an extra high pressure and transmitted to converting stations, from which it is distributed at high pressure to the service converters.

The corporation has erected a large station at Deptford, which has been admirably designed for the purpose, having road frontage, wharfage, and coaling dock. The plant consists of 24 "Babcock and Wilcox" boilers, four compound vertical engines by Hick Hargreaves & Co., two of which are 1,500 indicated horse-power each, and two of 750 indicated horse-power each. There is almost unlimited room for future extension.

Each of these engines drives a Ferranti dynamo by cotton ropes, the exciters being driven direct from independent engines.

In order to convey the high pressure from Deptford to London, Mr. Ferranti devised a special form of main for this purpose, which has been frequently described.

About 28 miles of these mains have been laid, the distributing mains from the converting stations being of various kinds. This company's Grosvenor Gallery station having lately been closed, a hurried change has had to be made in order to enable the corporation to supply from Deptford.

#### *Chelsea Electricity Supply Company.*

This company's provisional order covers the whole parish of Chelsea, a portion of which the company is now supplying.

Direct current is employed with accumulators, but, unlike the other companies in London, in this case the accumulators are charged with a high pressure current, and discharge direct at low pressure into the mains. I am not in possession of any information of this company's progress. From published descriptions you will doubtless be aware that the generating station is situated at Draycot Place, with battery stations at Clabon Mews, Egerton Mews, and Pavilion Road.

#### *The Electricity Supply Corporation.*

This company obtained a provisional order in 1889 for supplying the whole of the parish of St. Martin's-in-the-Fields. Direct current, without batteries. The station is placed just off the Strand, and was laid down some years ago by Messrs. Gatti, to supply the Adelaide Gallery and the Adelphi Theatre; it is now being extended. At present the plant consists of:—

Four "Babcock and Wilcox" boilers.

Five Willans's engines, amounting to 600 indicated horse-power.

Five "Edison-Hopkinson" dynamos, each being driven direct from one engine. Callender mains are laid down in Callender-Webber casing.

#### *St. Pancras Vestry.*

The vestry have decided to carry out the electric lighting of the parish themselves, and have secured the able services of Prof. Robinson as their engineer. The direct current system will be adopted, and a station is now being erected in Stanhope Street, Euston Road, for the supply of the south-west portion of the parish.

*Notting Hill Electric Lighting Company.*

The provisional order granted to this company includes the district of Notting Hill, which comes within part of the parish of Kensington, St. Mary Abbot.

The system is similar to that adopted by the Kensington and Knightsbridge Company.

The first generating station, situated off High Street, Kensington, is now approaching completion, the plant consisting of Babcock and Wilcox boilers, Willans's engines, Crompton dynamos, and Howell batteries; Crompton's mains are also laid.

*The Metropolitan Electric Supply Company.*

The Parliamentary powers of this company include the large and important districts of Paddington and Marylebone parishes, with part of St. Martin's-in-the-Fields, the Holborn and Strand district, and St. Giles's Board of Works.

Various systems are employed by this company, both the alternating and direct current systems being adopted.

The company is at present supplying from four stations, and it may perhaps be better to describe them separately.

The Whitehall station, situated in Whitehall Avenue, is a direct current station which possesses no novelty, and supplies the surrounding locality, the plant consisting of Hick Hargreaves' boilers, Willans's engines, and Siemens' dynamos. Callender mains are laid down the Northumberland Avenue Subway and elsewhere.

The Sardinia Street station contains a complete plant on the Westinghouse alternating current system, consisting of twelve Babcock and Wilcox boilers, working at 150 lbs. per square inch; twelve Westinghouse alternators, each being belt-driven by a Westinghouse compound engine. There are also three exciters, each being belt-driven by its own engine.

The Manchester Square station contains nine Babcock and Wilcox boilers, ten Parker alternators, each driven direct by a 200 horse-power Willans's engine. There are also four exciters, each being driven direct by a Willans's engine. The steam piping is arranged on a method devised by Mr. J. H. Rosenthal, the London manager of the Babcock and Wilcox Boiler Company, and possesses many advantages.

The Rathbone Place station contains plant of a similar kind, there being five boilers, six alternators and engines, two exciters and engines.

The system of distribution from the three latter alternating current stations is of a simple description—cast-iron pipes laid underground form conduits, into which "Silvertown" vulcanised rubber cables have been drawn when required. Split T-pieces are inserted in the pipes for connection to customers' premises. These mains are looped from house-to-house, returning to the station, so as to form complete rings. Each customer has, therefore, a duplicate supply, thus enabling new customers to be connected to the system without interrupting the supply on the circuit.

All these three stations are connected together by trunk mains, which enable one station to assist another, or take the whole load of the district during the hours of least demand. The current leaves each of these stations at a pressure of 1,000 volts, this moderate pressure being adopted as the number of supply stations reduces the distance to which each cable has to be laid to meet the demand. The whole supply is distributed by a number of small cables, which can be easily replaced when required.

The demand for light has been very encouraging; and, as you will see from the table,\* the progress of the lamp connection to these stations has been very rapid. I regret, however, to say that, although this company at present supplies light to 12 public-houses, only four churches are, so far, connected with the system.

Having now completed our tour of the stations of the various companies, we have seen how the streets of London have lately been disturbed in order to lay all these mains; no doubt a certain amount of inconvenience has unavoidably been caused to traffic, but it has revealed the wonderful system of organisation by which London is governed; and the vestry surveyors, whose labours have been much increased, have not only afforded every facility for carrying out the work, but have rapidly re-instated the pavements at, of course, the cost of the respective electric light companies. The public, therefore, though for a short time inconvenienced, have in reality secured new pavements for old.

Summarising the plants adopted by the various supply companies, it is interesting to notice how the peculiar conditions of electrical supply in the very limited space usually available have been provided for by manufacturers. As an instance of this, it may be noted that "Willans's" engines, amounting to about 9,000 horse-power, are used by the public supply companies in London; and similar engines, aggregating more than 2,000 indicated horse-power, for private plants in the metropolis. The Babcock and Wilcox boiler having also been so universally adopted, it may be of interest to state that 78 boilers of this type, supplying 14,230 indicated horse-power, are now at work in London.

*Private Plants.*

One result of the Act of 1882 has undoubtedly been to cause a large number of private installations to be erected, but so many of our leading electric light contractors have laid down thoroughly efficient plants that there is perhaps no cause for regret. Most of

the large terminal London railway stations work their own electric light machinery, the largest installation being at Paddington, where the Great Western Railway Company have machinery of 1,500 horse-power for this purpose. For residences, gas-engines provide the motive power for driving dynamos supplying about 18,000 lamps of 32 watts each, the remainder being steam-driven.

It may be of interest to note that the Crossley "Otto" gas engine, which was awarded a gold medal at this Society's recent motor competition, is being employed for this purpose, amongst others, by Messrs. Laing, Wharton and Down. This total may appear large, but it must be remembered that many of the large hotels having their own steam plant for working lifts, warming and cooking, have added electric lighting machinery; the total also includes the lamps at D'Oyly Carte's new theatre, where Messrs. Verity have erected a plant so complete, that it may almost be considered as a small central station.

*Number of Incandescent Lamps now in Use in London.*

With the kind assistance of the electric light contractors, particularly Messrs. Verity, Laing, Wharton and Down, Phipps and Dawson, Drake and Gorham, Sharp and Kent, and many others, and the public supply companies, I have been able to collect data that the total equivalent number of 32 watt lamps now in use in London is approximately as follows:—

Public supply companies	179,060
Private plants	85,000
Total	264,060

At the present rate of increase, a very moderate estimate gives an addition of at least 4,000 lamps per week, and there is little doubt that this number will be greatly exceeded at no distant date.

All these incandescent lamps have been calculated on a basis of 32 watts or 8 candle-power lamps, as experience has shown that this is a size much used in London, and, by taking the smallest lamp, we avoid dealing with half lamps.

Before leaving these particulars, it will probably be of service to the designers of future stations if we tabulate the data collected.

*Table Showing Percentage of Maximum Lamp Supply at any Moment to Total Lamp Connection.*

Station.	Percentage.
House-to-House	42
Kensington and Knightsbridge	30 to 40
St. James's and Pall Mall	57
Sardinia Street	45
Rathbone Place	64
Manchester Square	45

It perhaps may be of interest if I draw your attention to the following table, based upon data which has come under my observation, showing the candle-power of lamps mostly used:—

<i>Lamps (50 Volts).</i>						
8 C.P.	16 C.P.	32 C.P.	60 C.P.	100 C.P.	200 C.P.	500 C.P.
597	1,666	62	13	8	8	3
<i>Lamps (100 Volts)</i>						
5,437	5,131	176	26	57	40	3

During 1886 and part of 1887 I was able to collect the following data of the behaviour of incandescent lamps, each of 25 candle-power, with an efficiency of  $3\frac{1}{2}$  watts per candle, and I trust that more information of this kind will be collected.

With reference to arc lighting, considerable progress is being made; and, although the number now in use in London does not much exceed 1,000 lamps, there is no doubt that rapid progress will be made.

Prof. Silvanus Thompson, in March, 1889, showed you all the best known arc lamps; and, for further information of their development, I must refer you to his most complete paper on this subject, published in the Society's *Journal*, March 8th, 1889.

It is a matter for regret that there is no progress to be noticed in connection with the efficiency of the incandescent lamp, which remains much the same as it was five years ago. It will be apparent from the table showing the candle-power of lamps mostly used, that a really efficient 100-volt 8 candle-power lamp is much needed; the present lamps of this kind have such a short life that customers, contractors, and electric supply companies would all hail its advent as a boon.

We must also remember that the future progress of electric lighting depends in no small measure on the lamp-makers, and as the manufacture of the incandescent lamp will soon be open to all (owing to the expiration of the present patents), the absolute necessity of a standardising laboratory must compel its adoption where not only instruments but lamps can be tested, so that people may know when they ask for an 8 candle-power 100-volt lamp, with or without a guaranteed life of, say, 1,000 hours' at an efficiency of  $3\frac{1}{2}$  watts per candle, that they get what they have asked for.

That this question of lamp efficiency is of importance to cus-

\* This table, giving particulars of the Electric Light Companies of London, we published last week as a special page.—EDS. ELEC. REV.

INCANDESCENT LAMPS.—LIFE AND NATURE OF FRACTURE.

All Lamps 25 C.P. Brass Collar, Edison-Swan.

Lamps.			Nature of failure.											
Volts.	No. of lamps renewed.	Average life hours.	Glass globe.						Filament fractured.					
			Broken.	Per cent.	Blackened.	Per cent.	Plaster.	Per cent.	Loop.	Per cent.	Stem.	Per cent.	Joint.	Per cent.
151	536	861	114	21·2	21	3·91	56	10·44	208	38·80	114	21·26	23	4·29
142	189	789	19	10·0	4	2·11	41	21·69	67	35·45	47	24·96	11	5·82
120	2,549	923	273	10·7	92	3·60	334	13·1	1,114	43·70	693	27·10	43	1·68
99	588	1,423	122	20·7	61	10·37	92	15·64	212	36·00	95	16·10	6	1·02
	3,862		528		178		523		1,601		949		83	
				13·67		4·61		13·54		41·46		24·57		2·15

tomers and supply companies alike few will doubt, and the following Table will probably explain itself :—

Watts per candle.	Candles per 1,000 watts.	Lamps per 1,000 watts.			
		8 C.P.	16 C.P.	20 C.P.	32 C.P.
2·00	500·0	62·5	31·2	25·0	15·6
2·25	444·5	55·5	27·7	22·2	13·9
2·50	400·0	50·0	25·0	20·0	12·5
2·75	363·6	45·4	22·7	18·2	11·4
3·00	333·3	41·7	20·8	16·7	10·4
3·25	307·6	38·4	19·2	15·4	9·6
3·50	285·7	35·7	17·8	14·3	8·9
3·75	266·6	33·3	16·7	13·3	8·3
4·00	250·0	31·2	15·6	12·5	7·8

We see, then, how an improved lamp efficiency will benefit the supply companies, by enabling them to increase their lamp connection.

The following Table will appeal most strongly to all users of the incandescent lamp; but it must be assumed that an increased efficiency is not obtained at the expense of a reduced life of the lamps.

The most satisfactory feature, however, of the present Edison-Swan lamps is the uniformity of their voltage; and the scientific department of the Edison and Swan Company's work is to be congratulated on the assistance they have given to the industry, by practically enabling voltmeters to be set by photometrical tests of the lamps.

Cost per Annum per 8 Candle-power lamp at 8d. per Unit, Lamps Burning an Average of :—

Per day.	1 hour per day.	1 hour per day.	2 hours per day.	3 hours per day.	4 hours per day.
Hours per Annum.	182·5	365	730	1,095	1,460

Cost per annum with lamp efficiency of :—

	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
2 watts per candle	0 1 11	0 3 11	0 7 10	0 11 9	0 15 8
2·25	0 2 20	0 4 50	0 8 90	0 13 20	0 17 6
2·50	0 2 50	0 4 100	0 9 90	0 14 70	0 19 6
2·75	0 2 80	0 5 40	0 10 90	0 16 11	0 1 5
3·00	0 2 110	0 5 100	0 11 80	0 17 61	0 3 4
3·25	0 3 20	0 6 40	0 12 80	0 19 01	0 5 4
3·50	0 3 50	0 6 100	0 13 81	0 21 7	0 7 3
3·75	0 3 80	0 7 40	0 14 71	0 23 11	0 9 2
4·00	0 3 110	0 7 100	0 15 81	0 25 61	0 11 4

It may be thought that an estimated use of a lamp for only about 200 or 300 hours per annum is very low, but it should be remembered that the electric light need only be used when it is required, as the ease of switching it on and off makes us forget all our past troubles in hunting for gas-taps, matches, and broken gas globes. With ordinary care, the average cost of burning an 8 candle-power lamp for ordinary domestic use need not exceed ten shillings per annum.

Of course much depends on the wiring contractor, who not only has to be an accomplished art critic in designing or selecting the brackets, pendants, &c., but he has also to select the most advantageous positions for the lamps and switches. A switch placed near the door of every room, and not less than two lamps in any room, will probably save annoyance.

The greatest progress has been made in the wiring of houses,

Not only is more work done, but it is better done, and on more mechanical principles, for whereas some years ago a single main would have been run from top to bottom of a house with numerous T-joints, independent circuits will now be wired, and all brought to a neat form of distributing board.

The effect of the extra care which is now taken with this work is proved by the following table of insulation tests, taken with 100 volts at 200 houses :—

Insulation Tests of Internal Wiring (Taken with 100 Volts—Evershed Ohmmeter.

Number of points.		Test megohms.
5 to 10	Average of 15 houses	4·0
10 " 15	" 23 "	3·5
15 " 20	" 18 "	2·8
20 " 25	" 13 "	2·7
25 " 35	" 33 "	1·8
35 " 40	" 12 "	1·5
40 " 50	" 16 "	1·2
50 " 60	" 12 "	1·1
60 " 70	" 9 "	1·0
70 " 120	" 14 "	·4
120 " 220	" 9 "	·25

I hoped to have been able to place before you some record of the improvement in the health of London, owing to the progress of electric lighting, but so much has already been said and published about it that further facts appear needless. It is simply melancholy to see so many of our churches and halls not only burning their gas jets for lighting, but also for "warming" the building. If culpable negligence amounts to manslaughter, the people responsible for this atrocity ought to receive their deserts.

Having now placed before you some account of the progress of electric lighting in London, I must ask you to compare our metropolis with other cities, and leave you to judge whether we are so very far behind them as some would have us believe. Is it not more probable that other countries will be glad to avail themselves of the experience which London must gain in the working of so many distinct systems?

DISCUSSION.

Mr. E. E. CROMPTON said that electric engineers might feel proud that, although they had been so heavily handicapped in the race, they had begun at last to bring London to the front, and it would not be long before they were as far ahead of any other town in the world in electric lighting as they were in most other respects. The Act of 1882 completely stopped electric lighting for several years, though, as engineer to the Edison and Swan Company, he then designed several central stations which, even in the light of present knowledge, he could say could have been carried out practically as well then as they could now. Five years ago a gentleman called at his office and said he was connected with an estate company which had a subway, so that underground mains could be laid without coming under the Act, and the result was the formation of the Kensington Court Company, his informant being Mr. Granville Ryder, the present chairman of the company. At that time not a single underground main had been tried, and but for this opportunity of testing the system, it was very improbable that either the Kensington Court Company, the Whitehall, or the Metropolitan Company would have occupied the positions they now did. The results then obtained led to the agitation which produced the amended Act. The public should know that though they might have been inconvenienced by the breaking up of the streets, it was a very different thing from similar annoyances on the part of gas and water companies, because in most cases the work was done once for all.

Conduits or pipes had been laid, into which the conductors could be drawn, and from which they could be withdrawn and repaired, so that connections could be made without further breaking up of the road. He did not know the exact mileage, but he should think nearly 150 miles had already been laid, which was no small feat to accomplish since the provisional orders were obtained two years ago. In the system of underground conductors with which Mr. Bailey had connected his name—though he was by no means the sole inventor, many other engineers having contributed to its development—the idea was not only to give access to every house for the electric light, but to afford sufficient means of access for many other systems of conductors in future—telephone wires, fire alarms, and other means of communication, which would be greatly appreciated in future, and though the idea might now seem Utopian, he hoped the time would come when compressed air might also be supplied for the purpose of giving cool storage in every larder.

Prof. KENNEDY, F.R.S., said this paper would be much quoted after a few years, for Mr. Bailey had given a most vivid picture of the state of electric lighting in London, just at the time when it was most interesting. As to the maximum number of lights at one time in use as compared to the total number on the station, he had been apparently very fortunate in one of his own districts. He had found in Westminster the usual average was about 40 to 42 per cent., but one foggy day in last week it went up to 60 or 61, judging from the amount of current going out. As to the state of electric lighting in London compared with other places, there was no other city in the world that had 250,000 lights, or anything like it. He believed it was about double the amount in use in New York, and before long people would be coming here for information, instead of scoffing at us for doing nothing. With regard to safety in working the station, he thought that there should always be power in reserve equal to one of the largest units; if 200 horse-power engines were the largest used, for instance, there would be 200 horse-power in reserve, but the use of one 500 horse-power engine necessitated at least 500 horse-power in reserve, and so on. He should be glad to think that putting a boiler on a lower level than the engine would ensure having dry steam, but rather doubted whether that was proved experimentally. If the particular boilers mentioned gave dry steam, he did not think it could be owing to their position in reference to the engine.

Prof. FORBES, F.R.S., asked what the black spider-like lines on the map indicated? Mr. Bailey had collected an enormous number of the very facts engineers wanted to arrive at, and he hoped other gentlemen connected with central stations would follow his example and give the result of their experience. Mr. Bailey seemed rather hurt because various people had criticised the progress of electric lighting in this country, and contrasted it unfavourably with what was done elsewhere, and perhaps few had done more in that way than he (Prof. Forbes) had. He had taken the pains to learn what was being done in foreign countries by personal inspection, and had frequently, on his return from such enquiries, done his best to impress on those concerned at home the superiority of the work that was being done abroad. The last time he had occasion to do so was about three years ago, when hardly any of the work now described had been commenced; but he now thoroughly endorsed what had been said by Prof. Kennedy, that there was not an example in the whole world of such enormous progress in so short a time. They were delayed for a long time by the former Act, but during all that time they were studying what was done elsewhere, so that when they began they were on sure ground, and went ahead with more confidence than people elsewhere had done. Not only was the scale of work greater in London than anywhere else, but the character of the work in the central stations would bear comparison with any. Any one who had visited the Sardinia Street station would feel that it was as complete and satisfactory as it could possibly be.

Mr. W. M. MORDEY said that he believed this paper would be of the greatest value. He suggested that it should be followed, at fairly frequent intervals, with other accounts of the work that was actually being done. He remarked that Mr. Bailey's particular arrangement of primary mains, which was very simple and ingenious, had not been alluded to in the paper. It would be very useful if they could have not only the relative life of 50 and 100-volt lamps, but their relative efficiency. It would be well to know how much the lowering of the candle-power of the former counter-balanced the advantage of the longer life, the blackening of the globe in a low voltage lamp being always more serious than in the case of a high one. A strong confirmation of what had fallen from the Chairman and Mr. Crompton as to the effect of the Act of 1882 was to be found in experience abroad. It was often stated that our knowledge of how to distribute electricity had greatly advanced since 1882. This was true, but it was also true that, so far as supplying lights in a densely inhabited district was concerned, no great advance had been made or was to be expected. As an illustration of this, he referred to Milan, where a large scheme had been carried out on the lines that were available in 1882. Just about 1883, a station was put down there which had never had the current off the mains for six years, and it was now supplying 25,000 16-candle-power lamps, on the direct low-tension system. The history of that station showed that, in a dense area, the old-fashioned system was very good in its way, even without the advantage of the three-wire arrangement. Distant places—suburbs, and so on—could not be supplied, but they were now supplying the more distant parts on the high-tension system, somewhat similar to that mainly used by Mr. Bailey's company. The history of the Metropolitan Company illustrated the advance

in knowledge of how to distribute light over a large area economically, especially in the early stages of the work. That company started with a low-tension system and with batteries; but all the stations added since were on the high-tension system, without batteries. They knew now how to supply both in dense areas and over long distances. Mr. Crompton had, in London, perhaps done more than any one in the former direction, and the Metropolitan Company more than any one—except, perhaps, Mr. Ferranti—in the latter. A great deal had been said by Mr. Preece and others in that room on the advantage of lighting streets by arc lamps. It appeared that there were only about 1,000 in use in London altogether. He thought the general public would never fully appreciate the advantages of electric lighting until the whole of the main streets were illuminated in that way. Nothing had been said about the electric lighting of the City, no doubt for the reason that there was at present no lighting in the City. This reproach would shortly be removed, his company and others having undertaken a general lighting scheme, which, he was glad to say, included street lighting by arc lamps.

Mr. R. W. WALLACE pointed out the great importance of endeavouring to improve incandescent lamps. He believed, from some experiments which had been made, that it would be possible to reduce the amount of current used in these lamps by about one-third, though the result might be to shorten the life of the lamp. But when one considered the value of the lamp compared with the price of the current for a number of hours, that would be but a small matter. He hoped, therefore, that inventors would turn their attention in this direction.

Mr. CHAPLIN said it would be very interesting to know if there were any data showing whether an incandescent lamp worked with a low-tension current had a much longer life than one worked with a high-tension.

Mr. BAILEY, in reply, said that so far as he could ascertain there were now 81½ miles of conduits of all kinds, in some cases pipes, in others concrete or brickwork; and into these conduits were led about 111½ miles of cable, which were actually carrying current at the present moment; and that had practically been accomplished in 18 months, in order to supply the public with electric lighting, but they had not yet got to street lighting. That brought him to the question of arc lamps. Everyone would like to see arc lighting, but they could never expect to see it in London in such perfection as in Milan and other places where the streets were practically built for it. One could not imagine the Strand looking particularly handsome, even with the aid of arc lamps; it was quite different in Berlin, where they could be placed in the centre of the roadway on very high masts; but such as the streets of London were, they would be immensely improved by arc lighting, and he believed this would come shortly; and in place of the very meagre account of this system which he had been able to give, he hoped before long to hear someone else give a much more ample description of what was being done in this way. Everything was now ready for it, and he could not quite understand what kept it back. Prof. Kennedy had referred to the maximum percentage of supply to the total lamp connection, as to which you might take either the average or the heaviest day, the figures given in the paper being the heaviest lighting day in November; and he found that in all the districts from which he had collected information that the heaviest duty came on between four and five in the afternoon. (He exhibited a number of diagrams showing the varying amounts of current demanded during the day, plotted on a curve, taken at different stations and on different days, the highest point varying according as the district consisted mainly of offices, shops, or theatres and restaurants.) The black spider-like lines which Prof. Forbes referred to, showed overhead wires, and he desired to emphasise what he had said in the paper on this point. There were over 25 miles of these overhead lines, and he could not remember a single accident attributable to them. The prejudice which existed against them was due to the wretched work done in New York, where they neither suspended the wires nor properly insulated them, but left them to rot, and then people said how dangerous they were. Mr. Mordey had kindly alluded to the arrangement of mains which he was endeavouring to carry out, and which he (Mr. Bailey) did not allude to in the paper because he did not want to advertise himself. There was no particular novelty about it; they were merely acting on mechanical principles, and endeavouring to give people a double supply, one from each end of the cable, so that when a new customer wanted to come on, there was no need to go round to all the subscribers and tell them they must be shut off. With reference to the incandescent lamps, he hoped others would keep a record of the behaviour of all the lamps under their charge, which could easily be done. He had an India-rubber stamp, with a movable date, which was stamped on the cement when the lamp was sent out; when it failed, and was brought in to be replaced, the storekeeper could tabulate the date and the fracture in the filament, and these records would be very valuable. In a few years' time it would be open to anyone to make lamps; and people then would buy from those who produced the cheapest and most durable. Mr. Mordey had referred to the Whitehall Company, and the alteration they had introduced in the other districts as the system developed. That was due to the size of the districts which that company had to light; it was not only a question of providing light, but of doing it quickly, for nowadays, as soon as anyone had his place wired, he wanted the current the next day; and if he did not get it, he worried the life out of the unfortunate engineer to the supply company. He hoped, before long, someone would read a paper showing the benefit to the health of the people conferred by electric lighting, the decrease in headaches and in

doctors' bills. The other day a certain firm took proceedings against an electric light company for not continuing the supply, and stated on oath that whereas with the electric light they could go for six years without decorating their premises, when using gas they had to paint and whitewash every two years, and they claimed damages in consequence. He hoped the vestries would soon see the advisability of lighting the streets by arc lamps.

The CHAIRMAN, in proposing a vote of thanks to Mr. Bailey, said he prophesied two years ago that in ten years time 90 per cent. of all the houses in the West End of London, of £400 a year rental and upwards, would be lit by electricity. He now began to think that he had not been sufficiently sanguine, and that he might have mentioned a rental of £300 instead of £400. So long as gas was supplied at 2s. 9d. or 2s. 6d. per 1,000 feet, the electric light, until improved in some way—and the only improvement that seemed possible was economy in the lamp—must be a light of luxury; but persons who would pay £300 or £400 a year rent, were willing to pay £20, £30, or even £40 more for electric lighting, as compared, not with gas, because many would not use it, but with the other illuminants they employed. After a year's experience of the use of a number of lamps equal to about 114 8-candle lamps, he found the extra cost was between £20 and £25, as compared with the gas, candles, and lamps he used before, and in that he made no allowance for decreased expenditure in cleaning, painting, and matters of that kind, which was undoubtedly considerable. He had also a curious experience, during the summer quarter, of the truth of what Mr. Bailey said about the ease with which the electric light was extinguished and re-lighted. His summer quarter's bill for electric lighting was only a few shillings in excess of the gas bill for the previous year's summer quarter, and he bought no candles or lamp oil, having the electric light all over the house. The reason was simply this, that in a dark London basement, even in the summer time, the gas was kept constantly burning, but the electric light was turned out when not wanted, and though no doubt it was considerably dearer than gas, so much less of it was used, even by the servants, that it only cost a few shillings more.

### ELECTRIC LIGHTING OF THE NEW OLYMPIC THEATRE.

THE new Olympic Theatre, which is situated at the south end of Drury Lane, is now completed, and was opened to the public a fortnight ago. It has been erected, from the designs of Messrs. Crewe and Sprague, by Messrs. Holliday and Greenwood. The theatre is probably one of the safest in the metropolis, there being no less than 18 exits, and ample space everywhere for the comfort of playgoers. It has a lofty auditorium, which, by the aid of a sunlight in the centre, assists in ensuring efficient ventilation. Following the example set by the proprietors of other London theatres, Mr. Chas. Wilmot, who has provided the house for Mr. Wilson Barrett, decided to have it lighted electrically, and Mr. Harry South, of 10 and 12, Garrick Street, W.C., was commissioned to do the work.

The installation is not at present quite completed, but when finished it will comprise about 1,750 incandescent lamps, averaging 16 C.P. The boiler and engine rooms are situated in the basement of the building below the scene dock, and well removed from the auditorium, both being very compactly arranged. In the former are erected two Davey-Paxman locomotive type boilers of 60 H.P. each, working at a pressure of 120 lbs. to the square inch. In the same room the feed pumps and injectors are erected, the latter being worked by exhaust steam, by means of which water is fed to the boilers at a temperature from 190° to 200°.

The engine room contains three compound high speed engines, each of 40 H.P., which were specially constructed for the installation to run at a speed of 390 revolutions per minute. Two of these engines are coupled to corresponding dynamo shafts, which are driven direct; but lack of space prevents the same arrangement being carried out with the third set. In the latter case the dynamo is driven from the engine by ropes, the speed being increased by this means to 550 revolutions per minute. The output of each machine is about 300 ampères, at an E.M.F. of 110 volts.

The main conductors are led to a distributing switch-board, and are divided so that any one, any two, or all three sets can supply any one circuit. The question of

which arrangement should be adopted is determined by the "checks" in the piece, in such a way that any sudden alteration in the load, owing to dark scenes, &c., is immediately distributed over the second or third plant, if the particular one on which it is being run varies beyond a certain limit.

There are in all 45 circuits, each stage section being again divided into three at the "colour board," where the three different colours in which the stage is connected, unite. At the side of this is erected the checking board and resistances, the latter being of an entirely new design, and particulars of which are at present unobtainable.

Continuous practice in theatre lighting has induced Mr. South to seek patented protection for a number of ideas specially applicable to theatre work. These include a novel form of batten, only 6 inches wide and weighing only 2 cwt., a method of separate connection, &c., all of which are brought into use at the New Olympic Theatre.

### NOTES.

**Electric Lighting of Preston.**—During the last six weeks the National Electric Supply Company, Limited, has erected, temporarily, overhead wires, and installed some 300 incandescent lamps' besides arc lamps, in several shops and places. The lights were started for the first time on Thursday last, and created a most favourable impression in the town. The commencement has been a great success, and there is no doubt that the company's present venture here will lead to extensive future business. The whole of the work has been carried out by Mr. F. F. Bennett, late district manager of the National Telephone Company.

**Electric Light in Exeter.**—The City Council had under consideration last week the advisability of applying to the Board of Trade for a provisional order. A letter was read from the secretary of the electric light company, explaining its position with regard to the matter, stating that the company was a local one, and that every effort had been made to meet the wishes of the council. After a long discussion it was decided by a large majority that the council should apply for a provisional order.

**Ship Lighting.**—The Norddeutscher Lloyds' ss. *Gera* left the Clyde on Saturday for Bremerhaven, after going through a series of speed trials in the Forth. The vessel is intended for the emigration trade between the Continent of Europe and South America. An extensive installation of electric lights have been fitted up, and is available in all the passenger departments as well as in other parts of the ship. On the same day the Fairfield Shipbuilding and Engineering Company, Limited, launched the *Oldenburg* for the same company. This vessel will also be lighted throughout by electricity, provided by three engines and dynamos, each furnishing power for 365 incandescent lights. On Saturday afternoon the Palmer Shipbuilding and Iron Company launched at the Howden yard H.M. cruiser the *Pique*, the first of three second-class cruisers placed by the Admiralty with the Palmer Company. The *Pique* will have a complete installation of the electric light.

**Electric Lighting of Inverary Castle.**—Sometime ago the electric light was introduced into several of the rooms in Inverary Castle. We understand the Duke of Argyll now purposes lighting the whole of his castle by electricity.

**Electric Light in Berlin.**—The Berlin Electric Lighting Company now supplies current for 100,000 8-candle-power incandescent lamps, and for 3,000 arc lamps, the total current supplied being 60,000 ampères.

**"The Worst-lighted Town in England."**—At a meeting of the Plymouth Town Council, says a local paper, where public lighting came up for discussion, a councillor expressed the opinion that "they could go into any other town in England and it was better lit than Plymouth." There is an electric lighting company there, but it is beset by financial difficulties.

**Bristol and the Electric Light.**—Last week the members of the Electrical Committee of the Bristol Town Council journeyed to Bath for the purpose of inspecting the installation of the electric light. On arriving at the works they were met by Mr. H. G. Massingham (the proprietor), Mr. Hooker (chief engineer), and Mr. W. H. Preece, and conducted over the works. Subsequently the deputation made a *detour* of the city and acquainted themselves with the public lighting of the streets in addition to the private supply, expressing their unanimous satisfaction with everything they had witnessed. On Saturday the committee held a consultation in Bristol with Mr. Preece. A site for the installation was approved, and Mr. Preece gave it as his opinion that at first the light in Bristol ought to cost very little more than gas, and eventually it would be cheaper, if the corporation managed the supply. Mr. Preece went over the area—from the Victoria Rooms to Temple Meads Station—proposed to be lit, and was instructed to prepare estimates for an installation equal to 60 powerful arc lamps and 10,000 incandescent lights. The scheme, in its present form, is larger than was originally contemplated; but the committee are advised that the period for mere experiment has expired, and they are therefore determined to recommend the council to adopt a system of lighting that shall be permanent, and that shall be so successful as to ensure its very general use throughout the city and suburbs before many years have passed.

**The City and the Electric Light.**—A meeting of the Commissioners of Sewers was held on Tuesday in the Guildhall, when the Streets' Committee brought up a report recommending that the supplying of the western district of the City with the electric light should be entrusted to the Brush Electrical Engineering Company, upon the same terms that they had undertaken to supply the central district. After discussion, Mr. Pannell, who has been one of the principal movers in this matter in the City during the last six years, congratulated the Commission that when this contract was made, two-thirds of the City would have the benefit of the electric light. The report was carried. It was referred to the committee to consider as to the alleged danger of storing electric power.

**Croydon and the Electric Light.**—The County Council has received from Mr. W. H. Preece a detailed report as to the requirements for the probable cost of laying down the electric light in the town. He estimates that a total length of 100 miles of mains will be necessary for the service of the whole district, of which 60 miles can be underground, and 40 miles overhead, the latter being for public lighting only. The underground mains will cost about £700 per mile, the overhead about £230 per mile. To this must be added £2,500 for the feeding mains. The laying of all the mains underground would cost £60,500, or an extra £6,800. In addition to the above-mentioned amounts it will be necessary to provide the installations. Under these circumstances the corporation have decided, in their application to the Board of Trade, to mention £150,000 as the amount of capital which may be employed.

**The Folkestone Electric Light Committee.**—The town clerk states that, instead of the town being put to "the enormous expense of £700" by this committee, as stated at a public meeting, the legal and incidental expenses have not exceeded £120; in addition to which £50 has been paid to Mr. Preece for his opinion on the subject.

**The Barnet Electric Lighting.**—Now that the local authority has determined to end its contract with Mr. Joel, and as his intended application to the Board of Trade for power to supply the light in the district of the East Barnet Valley Local Board has met with no support from that body, we feel interested to learn what the next scene in this little "Comedy of Errors" will divulge. It seems that a return to gas is generally desired.

**London Theatre Lighting.**—The London County Council, debating on the subject of the electric lighting arrangements of the London theatres, has decided to engage Dr. Hopkinson, F.R.S., to report upon the danger, if any, of all the various systems in use. Mr. A. L. Steavenson has written on the subject of the dangers of electric lighting to a Leeds newspaper, recounting his own experience of fires caused by electric light plant in connection with collieries, and he states that a few weeks ago another colliery owner told him that since he had adopted electric lighting there had been two fires, the commencement of the last being actually witnessed by the manager. Yet the *World* states that danger from electric lighting is a sheer delusion. What a world we live in!

**The Electric Lighting Question in Maidstone.**—At a special meeting of the Maidstone Local Board, last week, it was resolved to apply to the Board of Trade for a provisional order. A request, asking the Local Board's assent, authorising the Electric Installation and Maintenance Company to obtain an order for lighting the borough, was refused.

**Serious Accident to Mr. Bernard Drake.**—On Friday last, Mr. Bernard Drake, of Drake and Gorham, met with a serious accident while inspecting the large electric light installation which the firm are just completing for the police authorities at the new Scotland Yard offices. After leaving the Receiver of Police, Mr. Drake passed out of the building by a door leading into the courtyard, which was left ajar, and immediately fell a distance of some 15 feet down an open area, the replacement of the grating of which had been inadvertently omitted. About half an hour elapsed before it was possible to extricate him from the confined space into which he had fallen; but he was eventually conveyed to the Westminster Hospital, where he was found to be suffering from a broken thigh and other injuries. We are informed that he will be confined to his bed for at least two months, and it will naturally be a great disappointment to him to be unable to superintend the completion of the work to which the firm has devoted so much attention during the past six months. We sincerely regret the very serious misfortune which will keep Mr. Drake so long confined, and we trust that his recovery may be complete. With Mr. Gorham we heartily sympathise in being so unfortunately deprived of the valuable services of his active and able partner.

**Commercial Cable Company.**—The *Canadian Gazette* of the 11th inst. says:—Our readers know the high opinion we hold as to these shares, and we are glad to state that at a recent meeting of the directors it was decided to raise the dividend from 6 to 7 per cent. per annum, beginning with the payment to be made the 1st of January next. At the same time the bonds to be drawn in respect of the year now closing will not be £40,000, as heretofore, but £120,000. In addition, there will be a very large surplus to be carried to reserve account.

**Boilers.**—Messrs. Ewen & Co., of Walbrook House, have just issued a revised edition of the section of their illustrated catalogue dealing specially with engines and boilers. With reference to the latter, they draw attention to their loco-type multitubular boilers, which they construct to steam at any pressure according to requirements. In all cases all plate edges are planed, all holes drilled in position, and the riveting and plate bending effected by hydraulic pressure.

**Junior Engineering Society.**—On Saturday the 6th inst., over a hundred members of this society and their friends made an excursion to the Central Institution. According to the printed programme they were received by Professor W. E. Ayrton, vice-president of the society, and were conducted by him over various rooms. In these were displayed a variety of electrical and other apparatus, experiments were performed, and the methods of testing the power and efficiency of arc and incandescent lamps were shown. The busy afternoon was brought to a close in the large lecture theatre. Here the guests seemed much interested in watching the working of a Telpher model. The vote of thanks, which was called for by Mr. Tennant, the energetic chairman of the society, was carried unanimously; and, after it had been suitably acknowledged by Professor Ayrton, the company dispersed.

**Lighting of Steamship Offices.**—The Calcutta offices of Messrs. Mackinnon, Mackenzie & Co., the managing agents in India of the British India Steam Navigation Company, Limited, have been fitted with a complete installation of electric light. The generating plant consists of a "Marshall" 12 N.H.P. compound steam engine erected on a wrought iron frame underneath a locomotive multitubular boiler. The engine drives by belt a "Manchester" compound wound dynamo having an output of 100 volts, 180 ampères, at a speed of 800 revolutions per minute. Throughout the offices, 140 32 candle-power lamps are fixed. The entire work has been carried out by the electrical department of the B.I.S.N. Company's workshops, Calcutta, under the superintendence of Mr. R. J. Browne, the company's electrician.

**Electric Light in Cornwall.**—The electric light has been successfully started at the Kennal Vale Paper Mill, near Ponsanooth (S. J. Polkinhorn). The dynamo was supplied, and the work most efficiently carried out, by Mr. C. J. Veale, of St. Austell. The dynamo is driven by a small 8-inch "Little Giant" horizontal turbine, weighing some 3 cwt., supplied by Mr. S. Howes, which develops six-horse power under a fall of 24 feet, carried by a flume 12 inches diameter, although the power required for driving the dynamo is only some one and a half horse power. This being the first installation in the district, it has excited considerable interest.

Freeman and Son's granite works at Penryn, which have hitherto been lighted by Wells's and other oil lamps, are now lighted electrically.

**Browett, Lindley & Co., Limited.**—The firm of Browett, Lindley & Co., has been converted into a company under the style of Browett, Lindley & Co., Limited, with a view to the immediate extension of plant and manufacturing facilities to meet the increasing demand for their patent "Acme" governors and specialties in high-class steam engines for electric lighting and other purposes. The *personnel* of the firm is in no way altered by the change, as the principals of the late firm are the managing directors of the company.

**Reform Club.**—This club is to be lighted by electricity.

**The Royal Society.**—Last night Messrs. H. L. Callendar and E. H. Griffiths were to read papers on the determination of the boiling point of sulphur and on a method of standardising platinum resistance thermometers by reference to it.

**General Electric Power and Traction Company.**—During the five months ending November, the electric cars of this company operating on the Barking Road section of the North Metropolitan Tramway Company's lines ran 27,597½ out of a possible 27,833 miles. On the 28th of last month, when there was a heavy fall of snow, the cars ran 193 miles out of a possible 213—a better average than was made by the horse cars.

**German Readers Please Note.**—An envelope, much torn, apparently from Berlin, was received, minus contents, by us on the 15th inst. If any one in Germany is awaiting an overdue reply, will he kindly send us a line to that effect.—[EDS. ELEC. REV.]

**International Exhibition, Moscow.**—A scheme is on foot for establishing a permanent general exhibition in the chief commercial city of Russia. Sales will be effected, and orders taken from samples. The agent in this country is M. Emile Cloes, C.E., 122, Cannon Street.

**Lightning and the Electric Light.**—A panic was produced a few days since in the town of Trente (Germany). After a heavy snowstorm, the lightning struck the building which supplied the electric light to the town, and darkness immediately followed. There was, however, more fear than danger, as the light was again available within a few minutes. A performance was taking place at the Teatro Sociale. The audience remained quiet, and the actors, preserving their presence of mind, continued their parts, without interruption, in the darkness.

**Electric Light in Madrid.**—Two companies, one English the other German, have recently obtained concessions for lighting districts in Madrid. The first-mentioned company has received applications for 6,000 lamps; its distribution is by alternating currents. The second employs continuous currents, and has been assured of a minimum service of 11,000 lamps; its station will be fitted with dynamos for the supply of current for 22,000 lamps, and it will be provided with Tudor accumulators, so as to bring the total number of lights up to 40,000.

**Personal.**—The *Elektrotechnische Zeitschrift* states that Lord Rayleigh has been elected honorary member of the Bavarian Academy of Science.

**Electric Organ in Verona.**—An electric organ has been erected in the S. Giorgio Church in Verona by Mr. G. W. Trice, of Genoa.

**Dr. Coffin's Electric Welding Process.**—It is reported that the English promoters of this process are about to establish works in or near London.

**Smoking Concerts in Favour.**—The staff of the General Electric Company held their first smoking concert at the Champion Hotel, Aldersgate Street, on Friday, the 12th inst. The chair was occupied by Mr. H. Hirst, and there was a large attendance, which included a number of well known friends of the firm. An excellent programme was gone through, including an exhibition of the gramophone, which excited considerable interest. It is proposed to hold the next concert on January 23rd, 1891.

**The National Telephone Electrical Society—Midland Branch.**—On Friday, December 5th, in connection with this Society, the President (Mr. Alfred Coleman) in the chair, the Vice-President (Mr. A. E. Cotterell, district manager) gave a very interesting and instructive paper on "A Few Errant Notions on Telephonic Matters." The paper was listened to by a large number of members, and was much appreciated. The Presidential Address was delivered by the President on Friday, November 21st, on "Telephony at the Present Time."

**Quanti est Sapere.**—We are glad to notify that the Council of the Institution of Electrical Engineers has awarded Mr. W. B. Esson the "Institution Premium," for his paper on "Some points in Dynamo and Motor design." This grant, together with his recent accession to the dignity of President of the Old Students' Association, will give Mr. Esson an earnest of the honours which are yet to be showered upon him. May he bear them modestly!

**"L'Electricien."**—From the 1st of January, 1891, *L'Electricien* and the *Revue Internationale de L'Electricite*, which have hitherto been published as separate journals, will appear as one, under the joint titles of the two. M. Hospitalier, we regret to say, owing to the pressure of other work, is unable to continue the editorship.

**O.S.A. Cinderella Dance.**—On Friday evening last a very enjoyable and successful dance was held at the Westminster Town Hall, in connection with the Old Students' Association of the City and Guilds of London Institute. Over 120 were present. In connection with the association, it may be mentioned that an excellent programme has been drawn up for the New Year, including four papers, three concerts, &c.

**An Important Event.**—The General Manager and Secretary of the St. James and Pall Mall Electric Light Company sends us the following note, dated December 17th, but what bearing it has upon the subject of electric lighting is more than we can divine:—"The Right Hon. A. J. Balfour, M.P., and Mr. G. W. Balfour, M.P., this evening visited the central station at Mason's Yard, Duke Street, Piccadilly." We may soon expect to hear that Mr. Parnell has inspected the fire escapes at the headquarters of the London Fire Brigade, or that Sir Charles Russell and Mr. Gill have entered into a partnership with the object of placing before the public a financial newspaper on the commercial morality of which one may absolutely rely.

**Ferranti Mains.**—Touching the remarks we have made on p. 734 on "High Pressure Alternating Mains," it may not be generally known that Mr. Ferranti uses two of his concentric cables side by side with the inner copper tubes connected together in parallel as one lead and the two exterior tubes similarly joined up as the other.

**Gas v. Electricity at Lewes.**—The result of the poll of the ratepayers of Lewes on the question of adopting electric lighting for the public thoroughfares, has been a majority of 25 for gas; the numbers being 177 for this illuminant against 152 for the newer one proposed.

**The City and South London Railway.**—This electric line, the opening of which has been twice prematurely announced, commenced operations yesterday morning. We wish success to everybody concerned.

**The Globe Electrical and Engineering Company.**—We are informed that the business of this company has been transferred to the Electrical Supplies and Fittings Company, Limited, having offices and stores at 2, Carteret Street, Westminster, who are about to issue a catalogue of electrical supplies comprising particulars of their well known manufactures, and of a series of specialities for high and low tension distribution.

**Engines and Boilers.**—A reference to Mr. Bailey's Society of Arts paper will show the rapid development in London of the Babcock and Wilcox boilers and Willans's engines.

**A Correction.**—In our reference last week to the *Oracle*, when mentioning the Electric Construction Corporation, it was intended to refer our readers to our contemporary's pages for Monday, the 8th inst.

**Telegraph Expenditure.**—A report issued on the 18th inst., states that the total expenditure on telegraphs for the year ended March 31st, 1890, was £2,568,799.

**Russian Telegraphs.**—The staff of the Russian telegraph service has under deliberation the construction of a telegraph line along the shore of the White Sea between Kala and the Norwegian frontier. The only present means of communication is a bi-weekly postal service.

**Incandescent Lamp Renovation.**—We understand that Messrs. E. Böhm & Co., of Little Britain, are devoting attention to a process for lengthening the life of incandescent lamps. Discoloured bulbs can be opened and cleaned without interference with filaments or mounting, and it is said that when a lamp is thus treated, and re-exhausted and sealed, it is more durable than a new one.

**The Paris Electric Lighting Companies.**—The four principal electric light companies in Paris, who hold concessions for 18 years from the Town Council, are following the example of the Paris Gas Company, by seeking to obtain an extension of their powers to the year 1930. For this purpose they have submitted to the municipality a memorial offering to reduce the price charged for the electric light, provided their concessions are prolonged to that year. The memorial is under the consideration of the Third Committee of the Council.

**Electrical Industries in the United States.**—The following figures will give an approximate idea of the present development, in the United States, of those industries in which electricity is the chief factor, and which seem to necessitate addition almost every day.

		Force in H.P.
Arc lights ... ..	(number about)	235,000
Incandescence lamps ... ..	"	3,000,000
Electric motors ... ..	"	18,000
" railways ... ..	"	300
" " carriages ... ..	"	2,500
" " length of lines ... ..	"	280 miles
		475,000
		75,000

**Electric Light and Power in a Village of 465 Inhabitants.**—Collais, near Nimes, a village of 465 inhabitants, has just been lighted by electricity. The motive power for the 1,600 light dynamo is derived from a small waterfall. The streets are lighted by 25 lamps of 16 candle-power each. Besides lighting the village, the current is employed during the day in putting in motion the pumps for supplying certain parts of the village with water.

**The Electrical Lighting of the Diamond Mines.**—The installation for the lighting of the underground workings of the Central Diamond Mine, Kimberley, has just been completed, under the superintendence of Mr. R. Oliver G. Drummond. From the second annual report for the year ending 31st March, we find the De Beer's Mine circuit had been running about 15½ months, night and day, with the exception of a short stoppage on Sunday, and during that period there had been no cessation to the light, during working hours, except once, when the engine had to be stopped for 10 minutes to remake a joint. The plant from which the Central Mine is worked is situated within the mining area of the De Beer's Mine, and the company have obtained the right to run their wires through the busiest thoroughfares of the city, from one station to the other, so that they have every facility for lighting the club, public library, post office, court house, and their own private central offices in the diamond market, very cheaply, which they propose to utilise. Many of the large mercantile stores on the route are in treaty with the company, and will probably be supplied from the same source. The Masonic Temple is already lighted from the De Beer's station, and although more than a mile distant, by a system of electrical signals and switches, each ceremony is methodically illuminated, according to ancient custom, without the slightest hitch.

#### NEW COMPANIES REGISTERED.

**J. Tylor & Sons, Limited.**—Capital, £100,000 in £10 shares. Objects: To carry on business as mechanical, consulting, sanitary, hydraulic and electrical engineers and contractors, manufacturers of electrical plant and apparatus, waterworks fittings, &c. Signatories (with one share each): \* W. H. Tylor, \* Joseph John Tylor,

C.E., \* W. B. H. Drayson, \* Philip Bright, J. S. Maples, W. S. Salter, Thos. Allsop, all of 2, Newgate Street. The first four of the signatories are appointed directors. Qualification: 100 shares. Remuneration of ordinary directors, £60 per annum each. Mr. Joseph John Tylor is appointed chairman and consulting engineer, and Messrs. W. B. H. Drayson and P. Bright are appointed managing directors, upon terms to be agreed. Registered 8th inst. by Sydney Morse, 4, Fenchurch Avenue. Registered office, 2, Newgate Street.

**Foreign Electric Date and Time Stamp Company, Limited.**—Capital £100,000 in £1 shares. Objects:—To acquire an invention of an electro-mechanical date and time stamps, patents for which have been obtained in France and Italy. Signatories (with one share each): E. Berlin, 17, All Saints' Road, W.; J. R. Akerman, 139, Minories; J. P. Nurse, 16, Barford Road, Nunhead; G. J. Pocock, 4, Oswyth Road, S.E.; J. L. Stevens, 90 and 91, Queen Street; E. G. Taylor, 46, Brighton Road. The signatories are to appoint the first directors; qualification, £100 in shares; remuneration, £600 per annum, divisible. Registered 8th inst., by F. Fearon, 25, Parliament Street.

### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**J. E. H. Gordon and Company, Limited.**—An agreement of 15th September (filed 1st October), provides for the purchase by the company from J. E. H. Gordon, of 11, Pall Mall, and Wm. John Rivington, of 21, Gledhow Gardens, Kensington, the business of electrical engineer and contractor for the construction and supply of electric light machinery and apparatus, carried on by Mr. J. E. H. Gordon, at 11, Pall Mall. The purchase consideration is £30,000 in fully paid shares. The vendors are appointed joint managing directors for life, each of them to receive a salary of £1,500 per annum.

**Williamson Electrical Engineering Co., Limited.**—The annual return of this company, made up to the 12th inst., was filed on the 13th inst. The nominal capital is £5,000, in £10 shares. 250 shares are taken, and upon these £7 10s. per share has been called and paid, the paid-up capital thus being £1,875. Registered office, 14, St. Ann Square, Manchester.

**Blackpool Electric Tramway Company, Limited.**—The annual return of this company, made up to the 12th inst., was filed on the 13th inst. The nominal capital is £30,000, in £10 shares. The whole of the shares are taken up, 150 being considered fully paid up. Upon 2,850 shares the sum of £6 10s. per share has been called, the calls paid amounting to £18,525.

**Woodhouse and Rawson United, Limited.**—An agreement of 10th inst. (filed 11th inst.), between this company and James Thorne, of 85, Gracechurch Street, cites that by an indenture of 11th February, 1890, it was agreed to issue to the said James Thorne 100 fully paid preference shares, in consideration of the conveyance to the company of a certain invention and letters patent. The said preference shares were duly issued on the 7th February, but 36 of such shares have since been surrendered to the company, and have been cancelled, leaving still issued 64. Although an agreement for the issue of such shares was duly filed, such agreement does not define the distinguishing numbers of such shares, and it has therefore been considered advisable to file an agreement defining such numbers. The said shares are therefore numbered, by the present agreement, from 61,701 to 61,800 inclusive.

**Woodward, Grosvenor, and Company, Limited** (carpet manufacturers, manufacturing chemists, electricians, &c.). The statutory return of this company, made up to the 12th ult., was filed 24th ult. The nominal capital is £90,000, divided into 6,000 ordinary

and 3,000 preference shares of £10 each, 5,000 of the ordinary, and the whole of the preference shares, are taken up, the former being considered fully paid up. Upon the preference shares the full amount has been called, the total of the calls paid being £21,900, and unpaid £8,100.

**Franco-African Lighting Syndicate, Limited.**—At a special meeting of this company, held at 3, Bucklersbury, on the 19th August, it was resolved that the net profits be devoted, firstly, in payment of 10 per cent. per annum cumulative preference dividend, the balance to be distributed amongst the holders of the ordinary shares. If the syndicate be wound up, the surplus assets shall be applied, in the first place, in repaying to the holders of the preference shares the amount paid up thereon, and the residue shall belong to the holders of the ordinary shares. These resolutions were confirmed on the 9th September.

**Earthy Metals Company, Limited** (metallurgists, manufacturing chemists, and electricians).—An agreement of 10th ult. (filed 4th inst.) provides for the purchase by the company from Louis Falero, of 100, Fellows Road, M.F.S.I.E., chemist and electrical engineer, of certain secret processes and inventions for the production, isolation, refinement, and preservation in the metallic state of sodium, potassium, magnesium, and aluminium, and also patent rights in connection therewith. The purchase consideration is 20 fully-paid deferred shares of £50 each. The vendor is appointed managing director for five years. His remuneration is to be an annual amount not exceeding £5,000, as may be equal to one-twentieth part of the consideration to be paid in cash or shares by a new company to be formed, within five years, for acquiring the property and undertakings of the present company.

The statutory return of the company, made up to the 24th ult., was filed on the 5th inst. The nominal capital is £2,000, in £50 shares. 38 shares are taken up, 20 of these being issued as fully paid up. Upon 18 shares the sum of £750 has been paid, leaving £150 unpaid. Registered office, 1, Westbourne Terrace, Willesden Green, N.W.

### CITY NOTES, REPORTS, MEETINGS, &c.

#### The Gülcher (New) Electric Light and Power Company.

At the third ordinary general meeting, held at Winchester House yesterday, Mr. de Castro addressing the meeting, referred to the presence of the reporters. Last year he had a little difficulty with one of the representatives of the press as to whether their meeting was private or public. His view was that it was a meeting of shareholders, and that the public were not interested in the concern, as they were not quoted on the Stock Exchange. It was a question, however, which rested with the shareholders.

A Shareholder considered that it was going back a little to exclude reporters. Other meetings of a like nature were thrown open, and further, as they were nearly in a position to apply for a quotation, it would not be an advantage to exclude the press, he therefore proposed the admission, which was seconded and carried.

The Chairman, in making a few observations, said the period since June had been a very important one for the company. On the date mentioned they had the very small preference capital, comparatively, of £50,000; they had £12,277 subscribed (shown by the report published in the Review last week). They had also a further £6,000 second mortgage debentures, which they were obliged to raise in order to meet the extraordinary difficulty the company was placed in by a contract entered into in New Zealand. He was glad to say that things now were entirely different. They had found that, however prosperous a company might be, or whatever its prospects were, it was hopeless to expect that a company with so small a capital and burdened with such heavy mortgages—£16,000 of them bearing such a very heavy rate of interest—to declare dividends. To pay off the heavy debentures it was necessary to issue the balance of the capital; they accordingly issued the balance of the preference capital, amounting to £37,723. The whole had been subscribed very largely by those who held 10 per cent. debentures, also by new shareholders, who formed an excellent list. The capital, therefore, now stood as the report indicated. They would all admit that they had attained a position which neither the old nor the new companies had ever attained before. The business to which he referred as having plunged the company into difficulties was the undertaking

by mistake of a contract by the late manager, which cost over £13,000, being six times more than was estimated. This accordingly locked up a large sum of money. Looking at the business of the company, he would state at the outset that they were a manufacturing electrical engineering company; they did not supply electricity. The capital required for such a company was much greater. The capital, £136,500, invested in their own concern, left alone, would not pay, it would not produce an income proportionate to the outlay, even if they consented to lock it up; to make it pay, it would be necessary to lay out another £9,000 to produce a substantial interest upon the £25,000 or £26,000. Under these circumstances, it became a matter for the serious consideration of the board as to whether they should employ the uncalled capital. They decided in the early part of the year, if they could possibly do so, to avoid using it to any extent. At the suggestion of the board he had been occupied a greater part of the year in forming a syndicate which would provide, as mentioned in the report, for the lighting of the town of Wellington. It would take over the company's business in New Zealand, together with the benefit which they had in the contract for lighting. The syndicate had at last been formed, and £10,000 would be subscribed, of which the company would only risk £2,000 of their spare capital. He did not think it would be necessary for the company to find one shilling towards it, for he was of opinion that the shares would be applied for by residents in the colony. He hoped, therefore, when he met them again, they would not only be able to report the completion of the contracts, but the completion of the works, which will have been attained by the expenditure of this money, and the receipt of a revenue which would in itself enable them to declare a substantial dividend upon the whole of the capital of the company. There was another phase in the contract formed with the syndicate which was one of considerable advantage. If the company's goods continued to hold the position in New Zealand which they occupied now, the syndicate would become a very valuable customer, and they would gain directly and indirectly by the transaction. Another matter he referred to was the fact of the company contributing to the registration of the South Western District and Thames Valley Electricity Supply Company. In conjunction with powerful people they thought it would be well having regard to the tendency of the electric lighting business to run into central supply rather than into independent installations, to become interested in some district. While London was being portioned out among the great companies, they thought if the way was clear without any material expenditure it would be as well to get a company registered which would tend to secure the monopoly of the district. There was not, he was sorry to say, any net profit, but the gross manufacturing profits were £3,079 2s. 4d. Never since the company had been formed had they made one-third as much, and last year there was a loss of £1,417 6s. 6d., so that this business had improved during the year to the amount of about £4,500. The heavy interest on their mortgage debentures was the real reason they had been unable to declare a dividend; but for that they should have been able to declare a dividend of at least 3 per cent. Mr. Binswanger—one of their late directors—had retired; he had come on the board to represent some large debenture-holders, and since the bulk of the money had been paid off he had left it; while the directors had recently elected Mr. Hilton, a large shareholder, to assist them in the management of the company during the absence of himself, as he was going next week to visit New Zealand to see if he could obtain powers to light not only Wellington, but other towns in the colony. The chairman then went through the various items in the balance sheet *seriatim*. Referring to the paying off of debentures, and the raising of new share capital, he said that when they had applied for £25,000 new capital, the shareholders had come forward with only between £17,000 and £18,000. They had decided, then, not to stop half way, but to get their capital underwritten, paying 7½ per cent. interest. As to profit and loss, for the first time in the company's history this showed sales and receipts exceeding £20,000. They would remember that he had promised them that when their sales exceeded that amount the company would be able to declare a dividend, and he now ventured to say that his figures had been confirmed, for but for the interest on the debentures, they would have been able to declare a dividend of at least 3 per cent., and as the shareholders of the company held most of its debentures, they had received the money as interest, if not as dividend. There had recently been designed for them two very excellent little dynamos, suited to supplying houses requiring 20, 30, 40, or 50 lights, and not within the district of any supply company, as also a little motor, which might be worked from them, and which would do the work of a small gas engine. These had been advertised, and there was evidently going to be a considerable demand for them. Another branch of business that would become more important, in his opinion, than even their business in New Zealand, was that of electric welding. They had made a contract with the only people he knew who had been able hitherto to weld steel and cast iron with any success. They had already had the experiments carried on for nearly two years by customers of theirs, and one of their customers who had taken a plant costing some £1,100 or £1,200, and worked it for a year, had paid himself three times over. This was getting rumoured about, and he anticipated orders shortly from the large firms in the North of England. They had been lighting for the last two years the Spanish and French Exhibitions, and he had at last succeeded in securing the German Exhibition upon similar terms; he had also negotiated for the lighting of a Working Man's Exhibition, or rather of a Labour Exhibition, which was to be held in another part of

London, so that, between lighting the Crystal Palace and these exhibitions, their name would come forward more and more every day.

Major Cotton, in criticising the accounts in a friendly spirit, said the underwriting of the capital was somewhat of a mistake, and he suggested, in case of anything going wrong, the directors would be personally responsible. He regretted that Mr. Binswanger had retired from the board, as he was a most practical man. The directors' fees, as now paid, were very large, considering the work done. They did not go down to the works, and only met once a month, and the fees of £250 each seemed rather excessive. When he was on the board the directors were paid £100. Referring to the New Zealand estimates, it was a dreadfully erroneous affair, and he thought the committee of works ought to have examined carefully the contracts.

After further discussion, a shareholder proposed the election of Major Cotton on the board, but this meeting with the opposition of the chairman, the matter was dropped.

Mr. De Castro and Mr. Hilton were re-elected directors, as also Mr. Russell Day, the auditor.

A vote of thanks to the board concluded the meeting.

### Western Counties Telephone Company.

AN extraordinary general meeting of the Western Counties and South Wales Telephone Company, Limited, was held last Friday at the Grand Hotel, Broad Street, Bristol, Mr. Charles Nash presiding. The Secretary (Mr. Henry F. Lewis) having read the notice convening the meeting,

The Chairman moved the adoption of the following:—

"That the directors be, and they are hereby, authorised by this general meeting to borrow any further sum or sums of money on such security (but not so as to prejudice existing debentures) and terms as to interest or otherwise as they may deem fit, and to secure the same by debentures upon the whole or any part of the property, funds, assets, or effects of the company, and so that any sum not exceeding £80,000, including the £50,000 previously authorised and issued, may be owing at one time, but so that the money to be borrowed under the authority of this resolution or consent shall not bear a higher rate than 6 per cent. per annum, nor (without the consent of the National Telephone Company, Limited), a higher rate than 5 per cent. per annum." He would say a very few words upon the progress of the company's business during the present year. The number of subscribers to the exchange and to the trunk lines in 1885 was 779, in 1887 it had increased to 2,034, and in November, 1890, it had increased to 3,540. As to receipts, after the payment of royalties, they had increased from £8,064 in 1886 to £21,286 in 1889, and judging from the progress made during the present year he had no doubt that the amount for 1890 would exceed £26,000. It was also satisfactory to find that the increase was going on at a more rapid ratio than it was last year. In 1889 the increase in the business was at the rate of £325 per month; during the present year the increase had been at the rate of £411 per month—so that the increase on that of last year had been at the rate of about £1,000 per annum. All that had required capital to be expended, and that was the reason of the proposal now to issue £30,000 on 5 per cent. debentures. He need not say much about that. They believed the security was an excellent one. The surplus remaining last year, after paying interest on existing debentures, was £6,848. The surplus this year would certainly be very much larger, and the interest upon the debentures now proposed to be issued would be only £1,500, so that it appeared to the directors that the security offered was a very excellent one.

Mr. Read seconded the motion. He remarked that the progress of the company's business was satisfactory to the shareholders in every sense.

In reply to a question as to the expiration of certain patent rights at a future period, it was stated that the company were covering their district so well that there would be little or no room for any competing company.

The motion was unanimously adopted.

**Greenwood and Batley, Limited.**—The directors have declared an interim dividend at the rate of 7 per cent. per annum on the preference shares; but have decided to postpone the consideration of a dividend on the ordinary shares until the end of the financial year.

**The West Coast of America Telegraph Company.**—The coupons due December 31st on the debentures of this company, will be paid by Messrs. Barclay and Co., Lombard Street. Coupons should be left three clear days for examination.

**The West African Telegraph Company.**—This company announces an interim dividend for the six months ended June 30th, of 4s. per share.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 12th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Ltd.

## SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (December 11).	Closing Quotation. (December 18).	Business done during week ending December 18, 1890.	
					Highest.	Lowest.
250,000	African Direct Telegraph, Ltd., 4 p. c. Deb. Regd. and to Bearer	100	98 — 101	98 — 101		
1,381,380	Anglo-American Telegraph, Limited	Stock	48½ — 49½	48½ — 49½		
2,809,310	Do. do. 6 p. c. Preferred	Stock	85½ — 86½	84½ — 85½	86½	85½
2,809,310	Do. do. Deferred	Stock	13½ — 13½	13½ — 13½		
130,000	Brazilian Submarine Telegraph, Limited	10	11½ — 11½	11½ — 11½		
84,500	Do. do. 5 p. c. Bonds	100	101 — 103	101 — 103	11½	11½
75,000	Do. do. 5 p. c. 2nd Series, repayable June, 1906	100	104 — 108	104 — 108		
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	1½ — 1½	1½ — 1½	1½	1½
63,416	Do. do. Preference, Nos. 1 to 63,416	2	1½ — 2	1½ — 2		
\$7,216,000	Commercial Cable, Capital Stock	\$100	102 — 104	104 — 106	104½	104½
224,850	Consolidated Telephone Construction and Maintenance, Ltd.	14/-	7½ — 7½	7½ — 7½		
20,000	Crompton & Co., Limited, 7 p. c. Pref. Shares, Nos. 1 to 20,000	Stock	5½ — 5½	5½ — 5½		
16,000	Cuba Telegraph, Limited	10	11½ — 12	11½ — 12	11½	11
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18		
12,931	Direct Spanish Telegraph, Limited	5	3½ — 4½	3½ — 4½		
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10		
60,710	Direct United States Cable, Limited, 1877	20	10½ — 10½	10½ — 10½	10½	10½
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	13½ — 14½	13½ — 14½	14½	13½
70,000	Do. do. 6 p. c. Preference	10	14½ — 15½	14½ — 15½	15½	15
200,000	Do. do. 5 p. c. Debts. (1879 issue), repay. Aug., 1899	100	106 — 109	106 — 109		
1,200,000	Do. do. 4 p. c. Mortgage Debenture Stock	Stock	104 — 107	104 — 107	105½	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited	10	13½ — 14½	14 — 14½	14½	14
320,000	Do. do. 6 p. c. Debentures, repay. February, 1891	100	101 — 103	101 — 103		
91,800	Do. do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049 3,976 to 4,326	100	102 — 105	103 — 106		
325,200	Do. do. Bearer Nos. 1,050 — 3,975 and 4,327 — 6,400	100	102 — 105	102 — 105		
145,300	Eastern and South African Tel., Ltd., 5 p. c. Mort. Deb., 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 — 104	102 — 105	103½	103½
198,200	Do. do. do. to bearer, Nos. 2,344 to 5,500	100	101 — 104	102 — 105		
201,600	Do. do. 4 p. c. Mort. Debts. Nos. 1 to 2,016	100	...	100 — 102	101½	101½
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	7½ — 8½	7 — 7½xd	7½	7½
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½ — 5½	4½ — 5½		
70,000	Elmore's Patent Copper Depositing, Ltd., Nos. 1 to 70,000	2	3½ — 4	3½ — 4	3½	3½
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 pm. all pd.	2	1½ — 2½	1½ — 2		
20,000	Fowler-Waring Cables, Nos. 301 to 20,000	5	2½ — 3½	2½ — 3½		
180,227	Globe Telegraph and Trust, Limited	10	8½ — 9	8½ — 9	9	8½
180,042	Do. do. 6 p. c. Preference	10	14½ — 14½	14½ — 14½	14½	14½
150,000	Great Northern Tel. Company of Copenhagen	10	15½ — 16½	16 — 16½	16½	...
15,000	Do. do. 5 p. c. Debts. (issue of 1881)	100	101 — 104	101 — 104		
230,000	Do. do. do. (issue of 1883)	100	104 — 107	104 — 107		
9,384	Greenwood and Batley, Ltd., Ordinary, Nos. 4,667 to 14,000	10	11½ — 12½	10½ — 11½		
5,334	Do. do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11½ — 12½	11 — 12 xd		
41,800	India-Rubber, Gutta-Percha and Telegraph Works, Limited	10	18½ — 19½	18½ — 19½	19	18
200,000	Do. do. 4½ p. c. Deb., 1896	100	100 — 102	100 — 102		
17,000	Indo-European Telegraph, Limited	25	35 — 37	35 — 37	35½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000 (£10 p.)	10	9½ — 10	9½ — 10	9½	9½
11,334	Do. do. Preference Nos. 5,667 to 17,000	10	9½ — 10	9½ — 10		
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7		
100,000	Do. do. do. 6 p. c. Debentures	100	106 — 109	106 — 109		
43,900	*Metropolitan Electric Supply, Limited, Nos. 6,101 to 50,000 £8pd.	10	7 — 7½	7½ — 8	7½	7½
438,984	National Telephone, Limited, Nos. 1 to 438,984	5	4½ — 4½	4½ — 4½xd	4½	4½
15,000	Do. do. 6 p. c. Cum. 1st Preference	10	12½ — 12½	12 — 12½xd	12	...
15,000	Do. do. 6 p. c. Cum. 2nd Preference (£8 only paid)	10	9½ — 10½	9½ — 10½	12	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11/- only paid)	1	8½ — 9	8½ — 9		
9,000	Reuter's, Limited	8	8½ — 9	8½ — 9		
209,750	South of England Telephone, Ltd., Ordinary, Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	8 — 8	8 — 8		
20,000	Do. do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2½ — 3	2½ — 3		
3,381	Submarine Cables Trust	Cert.	108 — 112	108 — 112	109½	...
78,949	Swan United Electric Light, Limited	5	4½ — 5	4½ — 5	4½	4½
37,350	Telegraph Construction and Maintenance, Limited	12	43 — 45	43 — 45		
150,000	Do. do. do. 5 p. c. Bonds, red. 1894	100	100 — 102	100 — 102		
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4		
146,128	Do. do. do. 5 p. c. Debenture Stock	Stock	90 — 95	90 — 95		
3,200	Do. do. do. 7 p. c. Debts., Nos. 1 to 1,000	100	...	...		
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8½ — 9½	8½ — 9½		
290,900	Do. do. do. 5 p. c. Debentures	100	98 — 101	98 — 101	98½	...
30,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	2½	2½
150,000	Do. do. do. 8 p. c. Debts, repay. 1902	100	101 — 106	100 — 105		
64,174	Western and Brazilian Telegraph, Limited	15	10½ — 11½	10½ — 11½	11½	...
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½ — 6½	6½ — 6½	6½	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4½ — 5	4½ — 5		
200,000	Do. do. do. 6 p. c. Debentures "A," 1910	100	103 — 106	103 — 106		
250,000	Do. do. do. 6 p. c. Mort. Debts., series "B" of '80, red. Feb., 1910	100	103 — 106	103 — 106		
88,321	West India and Panama Telegraph, Limited	10	2½ — 3½	2½ — 3½	3	2½
34,563	Do. do. do. 6 p. c. 1st Preference	10	11½ — 11½	11½ — 11½	11½	11½
4,669	Do. do. do. 6 p. c. 2nd Preference	10	11 — 12	10½ — 11½	11	...
\$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mort (Building) Bonds	\$1,000	120 — 125	120 — 125		
175,100	Do. do. do. 6 p. c. Sterling Bonds	100	99 — 103	99 — 103		
42,853	*Westmstr. Elec. Sup. Corp., Ord., Nos. 101 to 42,953 (£3 only paid)	5	2½ — 2½	2½ — 2½		

\* Subject to Founders Shares.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7½—7½.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2½—2½.—House-to-House Company (£5 paid), 4½—5½.—London Electric Supply Corporation, Ordinary (£5 paid), 1½—1½.—Manchester Edison and Swan Company, £9 (£1 paid) 11/- — 13/-.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 1½—2½.—Preference, 4½—4½.

BANK RATE OF DISCOUNT.—5 per cent. (4th December 1890).

## PROCEEDINGS OF SOCIETIES.

## The Institution of Electrical Engineers, December 11th, 1890.

CONTINUATION of discussion on "The Working Efficiency of Secondary Cells" and "Notes on the Chemistry of Secondary Cells," by Prof. W. E. AYRTON, C. G. LAMB, B.Sc., E. W. SMITH, and M. W. WOODS.

(Authorised Abstract.)

Mr. S. JOYCE, jun., said he had gained some experience with pasted cells when discharged at high rates, and therefore requiring frequent repairs. After several repastings he found it very difficult to make the red lead paste stick in the positive plates, and then tried litharge paste similar to that used for negatives. Cells so made had proved very satisfactory.

Mr. D. G. FITZGERALD enquired by what authority, and for what reasons, the authors called the peroxidised plate the positive, and the spongy lead plate the negative? He, himself, had good reason for reversing the designations, and in this he was following the example of Volta and Berzelius. Speaking of the chemical constitution of the negative (peroxide) plate, he said it was generally believed that  $PbO_2$  enters largely into its composition; there is, however, reason to doubt whether any of this compound is present, for the behaviour of the active substance on the plates is quite different from that of the pure peroxide of commerce. If a plate be made up of 80 per cent. of pure peroxide and 20 per cent. of the so-called peroxide produced by electrolysis, the E.M.F. falls when the electrolytic product is spent, and the subsequent action of the cell is unsatisfactory. In his analyses of the electrolytic peroxide he had always found some percentage of moisture present, even after it had been dried at a temperature above  $212^\circ F$ . He believes the chemical changes produced by electrolysis is represented by the equation  $(PbO_2)_{10}, (H_2O)_5, PbSO_4 = (H_2PbO_5)_5, PbSO_4$ , and that electrolytic peroxide is  $H_2PbO_5$ . As regards the best kind of support or grid for the spongy lead, he said it was a mistake to use lead, for copper is in many cases much better. If the copper be left exposed local action takes place, but this is retarded by the addition of any alkaline sulphate. The beneficial effect of soda in secondary cells he attributed to the formation of a double salt which is easily reduced. Sulphate of magnesium has an extraordinary influence on lead plates, and by using a solution of it as electrolyte, he had got discharges 30 or 40 times greater than those obtainable from sulphuric acid. The strength of acid required attention when dealing with heavy discharges. Recently he had used acid having a maximum density 1.252, so that its specific resistance diminished as the cell discharged; in this way, and by the aid of copper supports for the spongy lead, he obtained a comparatively steady discharge of 2 amperes per pound gross weight of cell for 2 hours. With ordinary lead grids this would have been impossible.

Prof. PEREY asked the distinguished chemists present if the double sulphate really exists, and Prof. Ayrton inquired whether there were any simple tests, by which such sulphates, if formed, could be detected.

Dr. GLADSTONE said Mr. Hibbert and himself had concluded that there was no evidence of double sulphates being formed in the action of secondary cells. He believed the general idea as to the influence of sodium sulphate was that lead sulphate was more soluble in the mixture than in simple acid; this, however, was not confirmed by experiment.

Mr. CROOKES, the new president, said sulphuric acid had a great tendency to form double salts, and thought it very probable that such salts would be formed in the case under discussion. Some results published by Dr. Gore in the *Phil. Magazine*, also point to the same conclusion.

Prof. S. P. THOMPSON was interested to learn that, like any other battery, the greatest action occurs at the upper parts of the plates. This might perhaps have been expected, because of its being the path of least resistance, but as the variation of the resistance of sulphuric acid with density is peculiar, and as the denser acid falls to the bottom, the action might have been modified thereby. The details relating to the formation of plates, given in the second paper, were, he thought, not new, and were practically what any one having a knowledge of the properties of the substances used and of the reactions which it was desired to bring about, would have arrived at theoretically. For example, to oxidise the positives one would aim at producing the most powerful oxidiser in the shape of ozone, the formation of which is facilitated by strong acid, large current density, and low temperature. On the other hand to reduce the litharge on the negatives it was known that a large current density mainly produces gas, and that reduction is best effected by small current density, at a fairly high temperature. Bearing in mind these opposite conditions one readily realises that the plates should be formed separately and that the negatives will require a much longer time. Several years ago he tried cells with electrolytes other than sulphuric acid and found that phosphoric acid was the only one which gave fairly good results. Speaking of pasted cells, Dr. THOMPSON inquired whether the authors had noticed that the oxidation of the positive paste begins near the grid, and gradually spreads through the mass of the plugs, and whether a useless nucleus remained unacted on in the centre of each.

Replying to Prof. Thompson, Mr. E. A. HALL said he had made experiments on the capacity of cells with plates of different thickness, and found it independent of the thickness. This, he thought,

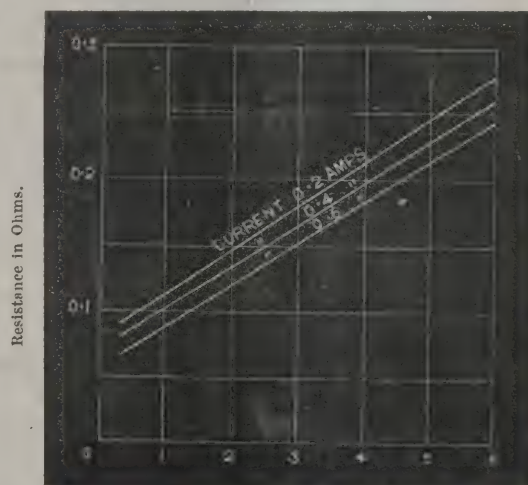
tended to confirm Prof. Thompson's view as regards a useless nucleus. On the question of acid density he found that the capacity of a cell was increased 15 per cent. by using acid of specific gravity 1.15 instead of 1.20.

Mr. PREECE rose to correct an error made by Mr. Drake at the last meeting in stating that the density of acid in the P. and O. battery had been 1.40. Mr. Hall informed him (the speaker) that it had never exceeded 1.22.

Mr. T. FRAZER took exception to the remarks made by Mr. E. W. Smith, in his reply to the discussion at Edinburgh, with reference to the formulae he (Mr. Frazer) had given for the resistance of cells for different currents, and for the fall of E.M.F. when the charging circuit is interrupted. In spite of what Mr. Smith said he maintained that his own statements were correct.

Prof. AYRTON, in replying, said the authors greatly appreciated the cordial reception given to the papers by practical engineers, for one of the aims of the Central Institution was to train students to do work and carry out investigations, the results of which would be of commercial value. Referring to Dr. Gladstone's criticism about the ammonium acetate method, he said that Mr. Robertson had used this method, but somehow or other the paragraph describing it had not been printed in the first proof. Speaking of measuring the resistances of cells, he pointed out that unless the curve connecting time and E.M.F. was discontinuous at the instant of breaking circuit, the method used should give correct results. So far as he knew there was no evidence of any such discontinuity. Mr. Crompton had said the resistance was practically independent of the distance of the plates apart, and that the sulphating of the negatives during rest depended greatly on light. Taking the case of resistance first, they had made experiments on a small two plate cell, and found that when the ordinary method of testing was employed Mr. Crompton's statement seemed nearly correct, but on using the more sensitive method illustrated in figs. 10 and 11 of the Edinburgh paper, this was not the case. Diagram A

DIAGRAM A.



Distances of plates apart in inches.  
Resistances of small secondary cell. Plates  $\frac{1}{4}$  inches  $\times$   $\frac{1}{2}$  inches.

represents the results of these experiments. To investigate the effects of light, darkness, and sulphate of soda on the liberation of gas from idle negatives, they had experimented on three similar E.P.S. cells. The fully charged negatives, designated by A, B, and C, respectively, were put in three different vessels of acid, one of which contained 0.8 per cent. of sodium sulphate, and the gases collected. A powerful arc light illuminated one set of plates whilst the other were kept dark. Plate A, when illuminated, gave off gas very rapidly, whilst B and C in the dark produced very small quantities, which were about equal. On interchanging the plates, however, it was found that neither light or sodium sulphate had any marked effect on the rate at which gas was given off, for whether A was illuminated or kept dark, or put in ordinary acid, or in the sodium sulphate solution, gas was liberated rapidly at about the same rate, whilst B and C were equally inactive under all the conditions. They therefore conclude that the rate at which gas is liberated depends on some peculiarity of the plates themselves. Some speakers, he said, had remarked that many of the facts brought forward in the papers were previously known. To this he replied that none of the facts given as new were known to the authors before they discovered them experimentally. Manufacturers might have been aware of them, but if so, they had kept them secret and never published them. For example, Dr. Gladstone, one of the highest authorities on secondary cells, was not aware of the differences in the hardness of the plugs at different parts of the plates until the appearance of their paper. Another case in point was the fact that Dr. Thompson said there was nothing new in the methods of forming the plates, whereas Mr. King apparently did not know of them. Mr. Swinburne had also called their attention to a prediction of the cooling of cells during discharge made in 1887, but at that time he admitted that he had not observed it. Speaking of the efficiency of cells, he said some people think the very perfect testing apparatus gave the cells their high efficiency; this, of course, was not true, for their figures merely express the results obtained when cells are used in a proper manner. Referring to a criticism on the Edinburgh paper, which appeared in one of the leading technical papers of July 25th, he said the writer had

only partly understood the early part of the paper, for they (the authors) had there explained that one of the objects of the investigation was to see what error could be made by neglecting the previous history and the resuscitating power of cells. The same writer had also stated that the results of laboratory tests were not applicable to ordinary working conditions. Here, again, he had fallen into error, for a secondary cell is a thing complete in itself, and if two or three selected at random give good results under proper treatment, so any number if similarly treated will show equal efficiency.

Correction in previous abstract.—The third word from the end of last sentence but one of Mr. King's remarks should be "circuit" instead of "surface."

### Physical Society.—November 28th, 1890.

Prof. W. E. AYRTON, F.R.S., President, in the Chair.

The following communications were made:—

"Additional Notes on Secondary Batteries." By D. J. H. GLADSTONE, F.R.S., and Mr. W. HIBBERT, F.I.C. After referring to the debateable points as to what compounds are formed and decomposed in the working of such batteries, the authors give the results of their examination of the red substance formed by the action of dilute sulphuric acid on minium, and which, Dr. Frankland believes to be a compound having the formula  $Pb_3S_2O_{10}$ . The ultimate analysis showed 72 per cent. of lead. A portion of the substance was treated with a 3 per cent. solution of ammonium acetate to dissolve out any normal sulphate that might be present; this left a residue much darker in colour than the original substance and containing 82 per cent. of lead.  $PbO_2$  contains 86.6 per cent. of lead. The colourless solution yielded a ratio of Pb to  $SO_4$  varying from 2.0 to 2.15; pure  $PbSO_4$  requires a ratio of 2.16 and Dr. Frankland's compound 3.23. From these results the authors conclude that the portion dissolved was not a basic sulphate, and that the evidence tells against the original substance being a chemical compound. The authors have also continued their comparative experiments in the action of spongy lead on dilute sulphuric acid, either pure or containing a small quantity of sulphate of soda. After the experiments had gone on for five months, the residues were analysed; that from the pure acid showed 82 per cent. of lead sulphate and 18 per cent. of metallic lead, whilst that mixed with sodium sulphate gave 89 per cent. of lead sulphate and 11 per cent. of lead. They therefore conclude that although the action of acid on lead is initially diminished by the presence of sodium sulphate, the final result is rather the other way.

Mr. G. H. ROBERTSON, who had used ammonium acetate to analyse plugs from storage cells, said he had arrived at results much the same as those stated by the authors.

Mr. SWINBURNE said Dr. Frankland was absent, but without agreeing with him, he would suggest that Dr. Frankland might say that ammonium acetate decomposed the subsalt  $Pb_3S_2O_{10}$ , and then dissolved the sulphate  $PbSO_4$ . The question might be attacked by acting on equal quantities of the substance, and the mixture  $PbO_2$ ,  $PbSO_4$ , in a calorimeter with ammonium acetate, to see if the same heat is produced; this would show whether the substance is a mixture or a compound.

Dr. S. P. THOMPSON was glad that the authors allowed a possibility of basic sulphate being formed, for it is well known that an almost irreducible sulphate resulted from leaving a cell nearly discharged; this he thought would point to a possible formation of a basic sulphate from  $PbO$  and  $PbSO_4$ .

Mr. SWINBURNE did not see where the  $PbO$  came from, except in newly pasted negatives, and he knew of no evidence of an intermediate stage of oxide on the plates. They appear to change directly to sulphate.

Dr. THOMPSON said that a rapid discharge was known to produce basic salts.

This, Mr. SWINBURNE thought due to deficiency of acid near the plates. Peroxide, he said, could not be formed on the negative without the acid was heterogeneous and gave rise to local currents.

Mr. W. HIBBERT, referring to Mr. Swinburne's statement, said he had put one plate of spongy lead into strong acid and another into weak, and from this arrangement obtained a fairly large current. As regards the basic sulphate spoken of by Dr. Thompson, he did not think there was much probability of its being formed. Time, he said, had an important influence on a partially discharged cell, and he would not expect to easily reduce the  $PbSO_4$  formed by the long continued action of lead on sulphuric acid.

The PRESIDENT enquired whether Mr. Hibbert's argument would apply to a fully charged cell.

Mr. HIBBERT, in reply, said that in this case the time required to produce sufficient sulphate to be irreducible would be very much longer, for in a partially discharged cell much sulphate was already formed.

Dr. GLADSTONE said he had anticipated that Dr. Frankland would raise the objection referred to by Mr. Swinburne. As far as he was aware there was no direct evidence either way, but he thought the suggested decomposition was improbable. If he acted on a mixture of  $PbO_2$  and  $PbSO_4$  he would expect to get the results actually obtained. Mixtures, however, were difficult to deal with, and the results not conclusive, for the physical condition of the mixture was not the same as that of the actual pro-

ducts. Referring to Dr. Thompson's remarks, he understood that it was the basic sulphate which he (Dr. Thompson) considered irreducible. Dr. Frankland, however, believed this sulphate more easily reduced than  $PbSO_4$ .

The PRESIDENT remarked that he thought Dr. Frankland had two reasons for his belief in the existence of the basic sulphates. One of these was the difficulty in reducing normal sulphate, whilst the other was based on the rapid fall of E.M.F. at a certain part of the discharge. It was at this point that Dr. Frankland thought the new sulphate formed, and to meet this argument it was necessary to find some other explanation of the rapid fall. In this connection he (the President) enquired whether there was sufficient peroxide formed on the negative plate to account for the drop.

On this point Dr. GLADSTONE could not speak decisively.

"An Illustration of Ewing's Theory of Magnetism," by Prof. S. P. THOMPSON, D.Sc. A number of small "charm" compasses were placed together on a glass plate of an ordinary vertical attachment to a lantern. A large magnet at a distance served to neutralise the earth's field, and a coil enabled a magnetising force to be applied in the plane of the needles. By this apparatus all the various phenomena exhibited by Ewing's model were beautifully shown on a screen. In the course of his experiments Dr. Thompson had found that when small magnets placed at moderate distances apart were used, it was much more necessary to neutralise the earth's field, in order that they might set themselves according to their mutual attractions, than when larger magnets were employed. A weak field directed the small openly spaced magnets, whereas with larger ones their mutual actions were much more powerful. This fact may, he thought, throw some light on the molecular groupings in magnetite (loadstone). This substance exists in two forms, viz., one crystalline, and the other of a heterogeneous structure. The former variety exhibits no magnetic retentiveness, whilst the latter is decidedly magnetic. As far as he was aware no sufficient explanation had been given of the non-retentiveness of the crystalline variety. A difference in the molecular distances, or groupings, might account for the peculiarity.

Mr. BOYS said it was rather curious that Prof. Rücker had just devised a somewhat similar illustration of Ewing's theory, and he exhibited it at the meeting. It consists of little magnets made of long V-shaped pieces of watch spring pivotted by glass caps on needle points; the needle points are fixed in little discs of lead stuck on a sheet of glass which forms the base of a glass box. An open helix surrounding the box serves to apply magnetic force.

Mr. SWINBURNE called attention to two theoretical points. First as regards susceptibility (which he regarded as a mere ratio and not a property), he said that if particles of iron at a high temperature rotate, as has been supposed, the susceptibility should be negative, and Prof. Ewing had some reason to think that this was the case. The next point concerned the loss of energy when an armature rotates in a strong magnetic field; this, he said, was known to be considerable, whereas if Ewing's theory is correct, he would expect little or no loss, for all the little magnets would always put themselves in the direction of the field and would never pass through positions of unstable equilibrium.

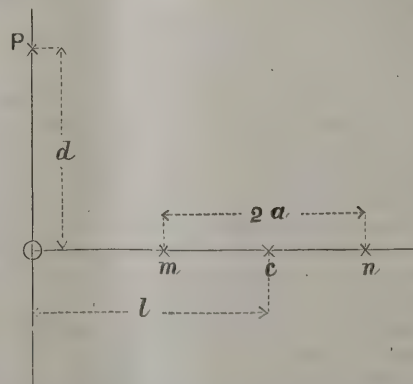
The PRESIDENT said he had discussed the question of negative susceptibility some years ago with Dr. Lodge with reference to the drop in the characteristics of dynamos, but he was not aware that any direct evidence had been obtained.

Prof. PERRY thought negative susceptibility might be possible in strong fields but not in weak ones.

Mr. SWINBURNE, on the contrary, considered its existence would be more marked in weak fields.

Mr. H. TOMLINSON said he had tried experimentally whether the susceptibility of nickel, when heated above its critical temperature, was negative, but he had not been able to detect it, although his apparatus was very sensitive.

"The Solution of a Geometrical Problem in Magnetism," by THOMAS H. BLAKESLEY, M.A. The problem referred to was the following:—Given the two poles of a magnet and a straight line intersecting at right angles, its axis produced, to determine at what point this line is parallel to the field. The question is of



scientific interest, because if the point be found experimentally, the distance between the virtual poles of the magnet can be determined, whilst it is important practically, from its bearing on the deviation of ships' compasses in certain cases. The instances in which it would apply are pointed out in the paper.

Assuming the points  $m$  and  $n$  (see fig.) to be the portions of the virtual poles and  $r$  the required point, it is shown that—

$$\frac{m}{(d^2 + m^2)^{\frac{3}{2}}} = \frac{n}{(d^2 + n^2)^{\frac{3}{2}}}$$

where  $o m = m$ ,  $o n = n$ , and  $o r = d$ .

From this expression  $\left(\frac{d^2}{2 m n}\right)^3 - \frac{3}{2} \frac{d^2}{m n} - \frac{1}{2} \frac{m^2 + n^2}{m n} = 0$

is deduced.

Now in hyperbolic trigonometry we have a formula—

$$\cosh^3 \theta - \frac{3}{2} \cosh \theta - \frac{1}{2} \cosh 3 \theta = 0.$$

Hence, making  $\frac{m^2 + n^2}{2 m n} = \cosh 3 \theta$  we have also  $\frac{d^2}{2 m n} = \cosh \theta$ .

The value of  $\theta$  can be then found by aid of the tables of hyperbolic sines and cosines compiled by the author and published recently by the Society. The distance,  $d$ , can thus be determined in terms of  $m$  and  $n$ .

A method of finding the point experimentally is then described, and the distance between the poles ( $2a$ ) shown to be given by the expression  $\frac{a}{l} = \tanh \frac{3 \theta}{2}$  where  $\frac{l}{d} = \sqrt{\frac{\cosh 3 \theta + 1}{4 \cosh \theta}}$ ,  $l$  being the

distance  $o c$ . The latter function can be deduced from the tables already referred to.

Experiment shows that the distance between the virtual poles soon approaches the length of the magnet, as  $d$  increases.

The strength of the field at  $r$  is given by the expression  $\frac{4 M}{d^3} \frac{\cosh^2 \theta}{4 \cosh^2 \theta - 1}$  where  $M$  is the moment of the magnet. This

can be simplified by arranging  $d$  and  $l$  so that  $\cosh^2 \theta = \frac{5}{4}$  and

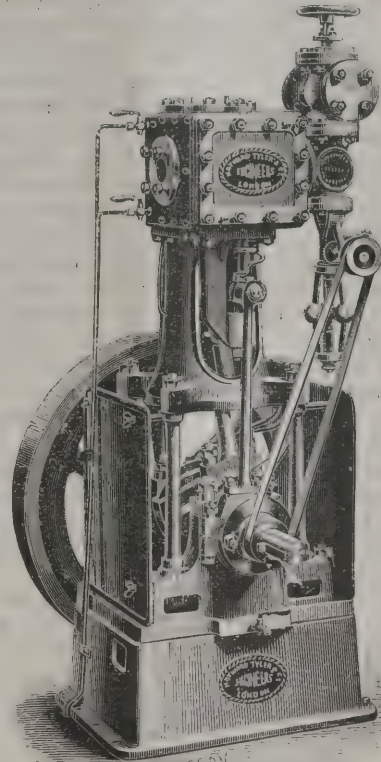
then becomes  $\frac{5 M}{8 d^3}$ .

Under these conditions  $\frac{l}{d} = .85065$  and therefore the angle  $o c r = 40^\circ - 23' - 10''$ .

## VERTICAL HIGH-SPEED ENGINE FOR ELECTRIC LIGHTING.

WE give an illustration of a new vertical high-speed engine constructed by Messrs. Hayward Tyler & Co., of Whitecross Street. It is of the single-cylinder double-acting high-pressure non-condensing type. The general design is new, consisting of a strong cast iron bed-plate having four mild steel vertical columns secured into suitable bosses. These columns carry a cast iron superstructure forming the guide bars, and a connection for the lower end of the steam cylinder. The bed-plate has the main bearings cast in one piece with it, and is provided at its lower edges with a capacious channel for catching waste oil. The cylinder is  $7\frac{1}{2}$  inches in diameter, and the piston has a stroke of 7 inches. The piston is of cast iron very deep, and fitted with Ramsbottom rings. The slides are of cast iron with ample surface. The valve is of a special double-ported type with short travel, and is connected to the valve rod by a circular gun-metal nut with a lock-nut and pin. The crosshead is fitted with square-bottomed gun-metal bearings, and a cap of steel forged solid with the guide slippers which are accurately turned and scraped to fit the guide bars. The connecting rod is of mild steel. The crosshead end is provided with a fork in which the steel crosshead pin is firmly shrunk. The lower end is of marine pattern with gun-metal bearings with flat backs, and having very ample surface. The crank shaft is of steel of double web type with large balance weights in one piece with the webs. The valve spindle is of steel of large diameter, forged solid with the guide, which latter is of extra size. The eccentric rod is of mild steel, with a bushed eye at the upper end, and a palm at the lower end for attachment to the eccentric strap. The eccentric is of cast iron, very wide, provided with a reversing plate, so that by simply changing a bolt the engine may be run either way. The eccentric strap is of best gun-metal of the stiffest shape and section, provided with steel bolts and extra deep nuts. The main bearings are of best gun-metal fitted into bored seats in the

bed-plate, secured by driven gun-metal stop pins. The governor is of the high speed type acting directly on a double-beat perfect equilibrium throttle valve, and is so constructed as to have no joints. It is adjustable whilst running. A heavy turned and polished fly-wheel is securely keyed to the outer end of the crank shaft close to the main bearing. The diameter is 3 feet, width 5 inches. A strong cast iron base-plate carries



the fly-wheel well clear of the floor line, faced on the upper surface, and provided with hand holes for bolts and a strong flange for securing to the foundation. Two lubricating boxes are fitted in suitable positions, so that by means of copper pipes the oil is carried to every bearing. Special means of carrying the oil from the lower ends of the pipes to the bearings are adopted, so that the whole can be oiled while in motion, and thus obtain constant running if necessary. Every part has been made strong enough for a steam pressure of 180 lbs. per square inch. The bearing surfaces throughout have been most carefully considered so as to secure perfect running. A speed of 350 revolutions per minute is about the best, but the engine will run without trouble at 450 if desired.

## COMMUNICATIONS FROM ITALY.

[FROM A CORRESPONDENT.]

THE alternating current central station erected at Venice by the Edison Company of Milan has, in consequence of the still growing demand for the electric light, been again enlarged by the addition of a fourth alternating current machine for 80,000 watts and the accompanying transformers. The electrical works at Venice are thus raised to the total capacity of 320,000 watts.

The same company is at present erecting at Intra an extensive electrical works on behalf of a local manufacturer named Sutermeister.

A large water-power is to be utilised by the transformation of its energy into electricity in order to supply electric light and motive power to the establishments in the valley. This installation presents an especial interest, since alternating currents are to be used both for lighting and for the transfer and distribution of

power. Consequently the electric installation of Sutermeister at Intra will be the first in which the alternating current will be used on an extensive scale for the transfer and distribution of power. The electric works are in the first place to comprise four turbines, of 150 H.P. each, and as many alternating current machines with the accessory exciters and accompanying apparatus, and they are now being begun with the erection of two turbines and dynamos.

The Italian villages Nicastro and Villaggio Bella have resolved on the introduction of the electric light to be supplied from a single central station to be erected at Nicastro. For public lighting in Nicastro, there are proposed 150 glow lamps of each 16 candle-power, 40 of 25 each, and 10 of 100 each, and, further, three arc lamps. For the streets of the village Bella, altogether 20 glow lamps of 16 normal candle-power each. The distance between the central station at Nicastro and the village Bella is about 1,300 metres. The installation, with regard to this distance, will work on the three-lead system, with an initial tension of 400 volts, and a tension of 200 volts at the lamps. To this end there are to be set up two "Oerlikon" continuous current dynamos, each for 65 ampères and 200 volts, which supply the three leads not in series with a current of 400 volts at the furthest conductors, whilst the lighting will be effected with glow lamps at 200 volts.

An official decree has been taken as the basis for lighting Monteleone di Calabria, where the electric works will be erected about 1,200 metres from the town. Here one place only has to be lighted, and that with a smaller number of lamps.

At Tivoli, the works for the extensive electrical installation of the Roman Gas Company are progressing, the workmen being already busy with the erection of the turbines and the dynamos in the central station. The formal opening is fixed for May, 1891.

### LIGHTING OF A POWDER MILL.

A RECENT issue of the *Bulletin International de l'Electricité* contains a description of the electric lighting of the National Powder Mill of St. Médard-en-Jalle. The directors had erected a small experimental plant at first, in order to test the applicability of the electric light throughout the works. The lighting being found satisfactory, MM. Sautter, Harlé & Cie., were instructed to put up a complete installation, which is now in full operation. There are installed nine arc lamps of 1,500 C.P., and a number of incandescent lamps, which are protected against breakage by glass globes and wire guards. Owing to the various buildings being some distance from each other, it was not easy to carry out the lighting arrangements. It was necessary to instal glow-lamps in buildings 975 yards from the generating station, and to maintain a constant potential of 110 volts at the end of a conductor of 45 mm. square section, whilst the consumption of current might vary from zero to 120 ampères. These objects have been attained by the employment of an extra compound-wound dynamo having two windings. One of these is in series and the other in shunt, and separately excited at a constant potential by an independent dynamo. The working of this machine has answered the anticipations put forward. When fully loaded, the loss in voltage at the distributing centre does not exceed 6 volts, and the independence of the arcs has been obtained. Two relays, one having a green and the other a red lamp, are placed in the engine room, so that any variations in the E.M.F. due to any change in the speed of the exciter may be ascertained. The dynamo, which runs at 800 revolutions, works 18 hours out of the 24 with a variable load.

## CORRESPONDENCE.

### Underground Cables.

Your issue of the 5th inst. contained a letter from Mr. C. H. Yeaman, to which was appended a communication from the Liverpool agent of the India-rubber, Gutta-Percha and Telegraph Works Company, of Silvertown, written under the direction of the London house, and containing two statements which are inaccurate and misleading, and which are liable, if uncontradicted, to injure our business. The statements are as follows:—

(1) "At West Brompton the Fowler-Waring cables on trial there have been abandoned, and our vulcanised rubber cables are exclusively used."

(2) "We believe the Fowler-Waring cables have been condemned; the reason Mr. Ferranti did not order the 10,000 volt cable from us is that he did not consider that they were within the bounds of possibility, commercially."

In reply to the first of these statements, the cables supplied to our company to the House-to-House Company at West Brompton have not been abandoned, but their use has been postponed owing to the difficulty of making two T joints on heavy lead-covered cables in a joint box  $3\frac{1}{8}$  inches  $\times$   $3\frac{1}{8}$  inches  $\times$  10 inches.

This difficulty is a serious one, but, I believe, we shall completely overcome it. Mr. Hall, the manager of the West Brompton Company, authorises me to add that the cables supplied by us, when tested in water, gave a higher insulation resistance than any of the cables supplied by the Silvertown Company; he assures me that only the difficulty I have referred to has prevented the extensive adoption of our cables.

In answer to the second statement, it is untrue that the cables we have supplied to Mr. Ferranti have been condemned; but as I understand Mr. Ferranti himself will deal with some of the other statements in this misdirected canvasser's epistle, I am content to leave any further remarks on this subject to him.

It is only due to the Silvertown Company to observe that they leave to agents the ungracious task of propagating inaccuracies and misrepresentations intended to injure their rivals.

Alfred E. Mavor, General Manager.

For the FOWLER-WARING CABLE COMPANY, LIMITED.

9th December, 1890.

In your issue of November 21st you publish a most interesting paper by Mr. C. H. Yeaman, "On Lighting from Central Stations. You also publish in your issue of December 5th a letter written to Mr. Yeaman by the Silvertown Company. In both of these publications my name is mentioned, and facts are not stated as correctly as I should have liked to have seen them.

To begin with, I may say that the amount of "wild talk" about 10,000 volts is quite unwarranted, especially as the people who speak about it have, practically, no knowledge on the subject. 10,000 volts, although it can be worked, and machinery and cables made to stand it, is not a thing which at the present moment is as easily dealt with as some people may imagine. Moreover, I may say that a cable which has to be used for a daily supply of 10,000 volts must be able to stand a very prolonged test of 25,000 volts at least with a considerable horse-power at the back of it.

Now, as regards the statement as to the abandonment of the Fowler-Waring cable by the London Electric Supply Corporation, Limited, I may say that this is quite incorrect. The only trouble that there has been with the Fowler-Waring cables has been in what they have been called, not in the cables themselves. They were, and are first class cables for the purpose for which we are using them, viz., the supply of current at 2,500 volts. If the cables were required for a higher

pressure they would have to be more heavily insulated, and this no doubt can easily be understood.

I may also add that our permanent distributing work is being done with insulators other than India-rubber, and that I do not propose to use India-rubber where I wish to have a lasting permanency.

S. Z. de Ferranti.

December 11th, 1890.

#### Improvements in Telephone Switchboards.

I should be glad if you could find room for a further letter on this interesting subject in reply to that of Mr. H. F. Jackson in last week's REVIEW.

In criticising my criticisms your correspondents have introduced arguments tending to show how the "improved" board would work if it had some other attachments than it has, or were in fact some other kind of board than it is; and Mr. H. F. Jackson refers to the single-cord system. The single-cord system is, telephonically, of remote antiquity, and it has been developed to a point of speed and easy manipulation which your correspondents do not apparently appreciate. But, so far as my information goes, those who have developed it and are fully cognisant of all its advantages, do not recommend its adoption for small exchanges. I have taken great care to prevent the assumption that the single-cord system was at all involved in the discussion, and the words "single-cord board" in this letter will be understood to refer only to the one of which a description was published in your columns on October 24th. I can now go back to the original questions raised by that description, viz., whether the single-cord board is superior in operating to a double-cord board with speaking keys, and which of the two is the more suitable for adoption in small exchanges.

In my article I referred to advocates whose opinions were entitled to respect. Mr. Jackson is clearly one of those. It is satisfactory that his opinions, and the grounds for them, have found expression.

I agree fully with Mr. Jackson in the two points to be aimed at. The first point is met exactly by the double-cord board; much depends upon the way in which the second is interpreted; and I would add a third to cover facilities for extension.

In regard to 1 (a): The insertion and removal of a plug count two for both boards. Any other value may be given them, but it must be on both sides of the account. That it may be seen my comparison was not unfair, I will examine Mr. Jackson's reasons for a reduction: It is because the first three movements are made with the same plug. There is a conversation between one and two. Frequently there will be ringing as well. Movements two and three are more nearly related, but are no quicker than plug movements, counting two on the double-cord board. There is no advantage by reason of the movements being made with one plug. There is a disadvantage which I will show later.

I have no difficulty in giving my reasons for asserting that the double-cord movements are done more quickly, and I think it will be seen that in practice it must be so. The time occupied in any operation depends on the mechanical work to be done, and the mental effort required to do it. There are seven plug movements, against five plug and two speaking key movements. If halves should come in anywhere, it should be on account of the speaking keys, but I have not claimed them. I prefer to leave it to any telephonic reader to estimate the value for himself. All the seven plug movements are slower by reason of the area to be covered, and one of them involves the selection of *some one* out of, say, a hundred, instead of *any one* (the nearest at hand) out of twenty or less. On the double-cord board, the only selection necessary is the second plug, to which the hand of the operator is guided by the cord of the first. Reply to 1 (b) is included in my second paragraph.

2. Simplicity of circuits. Mr. Jackson has overlooked a second contact on the engaged line of the single-cord board. It is in the unused spring jack. This narrows the question down to a simple one—the speaking-key contacts on an engaged line. It seems now that the only benefit conferred by the single-cord board is the absence of these two contacts.

Of course every contact is a *possible* source of trouble. On a well-designed switchboard every contact is also an aid to better working. "Troubles" of one kind may be largely avoided by a little trouble of another kind. In this respect let me compare the contacts on the two boards for the same number of subscribers. On the single-cord key-board there are 100 loose contacts open to dust and falling particles, on the double-cord key-board there are 80 spring-platinum point contacts protected from falling particles and so disposed that faults from "floating" dust are reduced to a minimum.

As a matter of fact, the trouble caused by keys is infinitesimal, whilst the advantages they confer are considerable. Their utility may be illustrated by reference to the diagram and description (October 24th), where there are none. The freedom from contacts is obtained at considerable cost. As speaking keys are so many branch lines by which the operator's outfit may be diverted easily and quickly to any circuit, an operator by their aid is able to "overtake her work." When there is only one means of access to the operator's instruments, as in the case of the single-cord board there are no such facilities, and she is consequently more "tied up," and putting through a number of subscribers in succession is a slower and more laborious process. Tapping a line in the one case is easy; in the other, difficult.

The "trouble" argument applies as much (perhaps more) to the cords. Mr. Jackson says that speaking keys might have been fitted. But surely if the argument is worth anything at all, it is an argument against the needless multiplication of either keys or cords. On a double-cord board the cords, and all the apparatus in their circuit, are auxiliaries only. In the single-cord board the cord is a link in the main line. It is, together with its contact, a weak link, and if it should be a broken link, the line is entirely disabled. This is bad for small exchanges, and especially bad in the case of small boards under private control. On the double-cord board a fault on cord, plug, or key does not interrupt a circuit. The afflicted set is placed *hors de combat* until it is convenient to repair it.

The greatest failing of the board to which I have drawn attention is confirmed in Mr. Jackson's letter, wherein he states that it is not usual to place two boards side by side, but to remove one board, and replace it by another as the subscribers increase. I will here define the third point which I suggested above. It is:—

(3) A switchboard with which an exchange is started should not need to be removed, but should be capable of being added to by other boards of the same kind until the exchange attains multiple rank.

Reasons which will justify changes and removals will occur to any exchange manager, but there are no reasons sufficiently good to establish, as a practice, such an unsound principle as removals with every increase of 20 or 50 subscribers. But for this correspondence I should have to apologise for expressing so well recognised a rule.

Mr. Jackson says it would be impossible to work 500 subscribers in a space of 10 feet. I enclose for your inspection a photograph of an exchange with ten 100-line boards. These boards are not 23 inches, but 17½ inches wide (the 23-inch board is a concession to appearances). I shall be glad to show the photograph, and give the name of the exchange to Mr. Jackson or anyone interested. This is an exceptional instance, but it goes to prove that the third point is not only theoretically safe, but practically attainable. The size of board to be adopted will vary considerably; 25 is a safe minimum and 100 a safe maximum, according to the varied circumstances which exchange managers have to consider.

In reference to the question of accessibility raised again in Mr. Jackson's postscript: the accessibility of the single cord board is nearly as good as the double for the same things. The reason why all the working parts can be reached from the back is, because there are no working parts anywhere else, and, as I have had to point out, it suffers in consequence. There are two accessibilities—one an operator's the other a mechanic's. If they do not happen to run together, it is so much the worse for the mechanic.

In reviewing the matter as impartially as one who has taken an active part in it can, I find that the numerous advantages claimed on October 24th are reduced to the two contact points. This advantage may be expressed by another point—a mathematical one. It has no magnitude.

Every switchboard is a combination of advantages and disadvantages which have to be carefully weighed. In the case of the double-cord board this has been done, with the result that probably nineteen-twentieths of the telephone world have adopted it for small exchanges. In the case of the single-cord board the balance may be easily struck, if the mathematical point be weighed against the very considerable disadvantages which have come out in the course of comparisons which I did not begin, but which I could easily continue in much greater detail.

J. E. Kingsbury.

December 16th, 1890.

#### Electric Light on Shipboard.

In my former letter on this subject a mistake occurred, which you pointed out by an asterisk and a foot note; the word should have been (*single wired*).

In regard to Mr. A. Campbell Swinton's remarks on my assertion regarding lead-covered wires, I may be permitted to explain that I treat the question of wires and their coverings from a rather different point of view than that taken by Mr. Swinton.

That the British Admiralty and others use lead-covered wire, and find it good enough for their purpose, is no proof, to my mind, that it is the best wire for ship lighting purposes.

Mr. Campbell Swinton, and those others who use lead-covered wires, admit that the lead acts simply as a waterproof covering; his letter amply proves this; it also admitted that the lead is not to be relied on for mechanical protection. Now I think a simple cable, having a continuous vulcanised rubber insulation, with a good braiding, comes quite up to the lead-covered cable, in so far as its being waterproof, and it does not require any more protection than the lead-covered wire. The question is this, whether is lead-covering or vulcanised rubber preferable as the waterproof in a cable for ship lighting? The lead covering is not an insulation; its object is to protect the insulation from water. The vulcanised rubber is the insulator in a cable, and can protect itself from water.

It is very well to get a cable from a maker guaranteed 500 megohms per mile, but after that you take, say, a hundred yards of it, cut the insulation away at a dozen places, make a joint at each, and cover them up again, soak it then for a week or two in sea water, joints and all, and then test the insulation. If the work is done by skill and with care, I admit that both lead and vulcanised cables will stand this test; but the tests would seem to make out that the lead covering is superfluous, seeing the vulcanised rubber can dispense with it, and the cost of making the lead joints is something extra.

I do not condemn lead-covered cables by any means. I think there can be nothing better for some purposes, and would use nothing else for long stretches of cables in tunnels, conduits, or underground work, where the covering does not require to be broken in many places, and joints are few and far between.

But in ship lighting, the unbroken lengths are short and the joints are many. Under these circumstances, my own experience is that a good vulcanised insulation, run in wood casings in the passages, saloons, and berths,

and in galvanised iron wire sheathing in the engine rooms, boiler stoke-holes, and shaft tunnels, and to the signal lights, is the best that can be done on ship-board, and so that the wire may be as short as possible, and the joints as few as possible, I prefer single wiring

Rankin Kennedy.

#### The Electro-Deposition of Copper.

Most of your readers will perceive, without any tedious elucidation on my part, how strangely Mr. W. Stepney Rawson misapprehends the drift of my letter. Because I say that, in considering a given case of electro-deposition from a general and abstract point of view (with the object of determining the expenditure of energy under any assumed conditions relative to *time* and *tank resistance*), we are bound to take the expression for energy  $C E \theta$ , rather than the equivalent

expression  $\frac{C}{n} \cdot E n \cdot \theta$  (with a concrete value for the

number,  $n$ , of tanks in series), he arrives at the conclusion that I am endeavouring to "justify the employment of a parallel system of electro-deposition." It is obvious from what I stated that, in regard to the arrangement of tanks in parallel or in series, there is no advantage apparent one way or the other until we come to practical considerations of convenience, &c., which may justify us in giving a concrete value to  $n$ .

In regard to Mr. Rawson's question, intended as a *reductio ad absurdum*, I am no authority in dynamo machines, but I think I may say that no large machines have as yet been constructed with so low a terminal P.D. as 1 volt. I have, however, some recollection of a machine by Siemens and Halske giving 1,000 amperes under a P.D. of 3.5 volts; and if a machine giving 3,500 amperes at 1 volt were really required (which it is not), I have no doubt but that it would soon be forthcoming. With  $n = 1$ , nearly the required quantity of work could be done with 21 such machines, or with a proportionately smaller number of machines of greater power.

Since I started the old *Electrician*, more than a quarter of a century ago, I have had much to answer for in the way of "leading articles;" and this may perhaps in some measure account for a tendency to use the editorial "we" in place of the egotistical pronoun. But I really must deny Mr. Rawson's soft impeachment in regard to this paper, for the simple reason that I have never written for it excepting over or under my own name. I am under the impression, moreover, that the editorial columns are entirely monopolised by the editors themselves. Although I consider Mr. Rawson's suggestion to be "rather bad form," I am personally not at all offended by it. But why, if things were otherwise than they are, should I not write even editorially for the REVIEW, provided I could get the Editors to accept my "copy"? Would Mr. Rawson suggest that I am not a fit and proper person, that I have interested motives, that I am biassed against himself, or the process in which he is interested? If so, I can only say that (having a few years ago spent a few pleasant hours in Mr. Rawson's company), any bias on my part would be in his favour, and that I have no interest whatever in depreciating any process for the electro-deposition of copper. Mr. Rawson, who seems to write with some bitterness, has apparently not noticed that we both, in my estimation, carried a point against the Editors in the matter of the number of working hours per week, and that my opinion as to current density allowable is decidedly favourable to the process above-mentioned.

Desmond G. FitzGerald.

**Electric Light in an Irish Factory.**—The whole of the immense buildings used by Messrs. Barbour and Co., thread manufacturers, Hilden, Ireland, have been fitted throughout with electric lighting plant. As showing the gigantic nature of this concern, one may mention that the buildings occupy a space of 35 acres, and over 5,000 hands are employed.

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THE TELEPHONE.

THE recent expiry of the Bell Telephone patent has, we believe, hardly led to the brisk trade in telephonic instruments which many manufacturers anticipated ; possibly the lull may be only a temporary one, and it may cease when the second master patent, that of Edison, has lapsed, as it does in the middle of next year. It is not improbable, however, that the National Telephone Company may not consider that their claws have been completely pared down ; but that, as owners of comparatively recent patents dealing with important details, they have still plenty of fight left in them. The question as to licenses to be granted by the Postmaster-General for rival telephone exchanges is yet in abeyance, and until something definite is decided, but little can yet be done. There seems to be an impression abroad, however, that were action made free, formidable competitors with existing systems, in the shape of instruments for loud-speaking and long-distance working, would soon spring into existence. Those who imagine this must be profoundly ignorant of the laws which limit the possibilities of telephonic working, and which are as definite as those which limit the possibility of working submarine cables beyond a certain speed. We have more than once alluded to what is known as the "K R" of a telephone line, and it is surprising how very few seem acquainted with, or realise the exact significance of, the law therein expressed. We hear it glibly stated that telephonic communication, say, between London and Glasgow, a distance of over 400 miles, would be quite practicable, it is only a question of getting instruments powerful enough. Undoubtedly it is possible to speak that distance and to speak well, but it is not a question of instruments at all, it is a question of wire ; make the latter of copper and sufficiently heavy and the thing is done, but then will it pay ? What return on the total cost of a copper double wire, weighing not less than

400 lbs. (and probably 600 lbs.) per mile would be required to be remunerative.

Seeing the wide spread area over which the National Telephone Company have cast their network and the number of their subscribers, it seems difficult to see how the public will be induced to subscribe to a rival exchange, as it will naturally be very annoying for the subscribers to find that the persons with whom they desire to converse are not on their particular system ; even the inducements of a good service and a low subscription would hardly compensate for this.

In the matter of instruments it is whispered that the National Company are well aware of the unsatisfactory character of the transmitters used by them, but in view of the fact that the introduction of an improved form to even a few subscribers would lead to a general demand all round for the better instruments, and a consequent heavy outlay, they are unwilling to issue any other type than that in universal use, viz., the Blake pattern. Referring once again to long-distance speaking, it is probable that the commercial value of the new London and Paris line may inaugurate a new era in telephonic enterprise. It is difficult to forecast whether this will be a financial success, but the result of the experiment, commercially, and not scientifically speaking, will be looked forward to with great interest. We say "not scientifically," because the satisfactory working of the line, telephonically, we consider to be, beyond doubt, the margin beyond the practical "K R" limit, being amply sufficient to ensure success. At the same time, many will, no doubt, consider the experiment as an engineering triumph.

TEMPERED COPPER.

THE *Journal of the Franklin Institute* for December contains the report of a sub-committee appointed to decide upon the merits of the products of the Eureka Copper Company. The company claims to produce by

new, unpatented (and therefore undescribed) processes, copper castings free from blow holes, and to harden them without destroying their fibre or impairing their usefulness for electrical or other purposes. Chemical analysis showed that both tempered and untempered samples were commercially pure copper. Physical tests showed that the untempered had 20 per cent. and the tempered 35 per cent. greater tensile strength than the average shown by a U.S. Government report (1878). One hundred letters were sent out to users of the material and 53 answers received, "in which a definite opinion was expressed." Of these, five saw no difference between the tempered copper and other metal and alloys; eight had tried it for unsuitable purposes; six were against, and 34 in favour of, the claims of the makers. Amongst the 34 the use of the material for commutator brushes and segments was particularly prominent.

The committee recommend the award to the inventors of the John Scott Legacy Medal and premium, as they "believe that the claims of the applicants are substantiated by the experience of the majority of the parties using the copper, and also by their own investigations."

The prominence thus given to results of practical use by placing them as of first importance, and their own scientific tests as secondary, is somewhat remarkable. We agree fully with the committee as to the importance of practical use, but as the scientific tests are entirely authenticated, and the reports of the users appear to be irresponsible, we think that in this case the order of importance should be reversed. It is not a majority of users who substantiate the claims, but 34 out of 100, 47 either not replying or being indefinite in the expression of their opinions.

The advantages of such a material being considerable, there is no doubt its capabilities will not lack practical tests.

### MANNESMANN TUBES.

THE same journal contains particulars of tubes rolled by the method invented by Reinhard and Max Mannesmann. The method is of special use in making pipes designed to withstand heavy pressures. The process consists in feeding a solid heated bar of ingot metal between rolls which, while their axes are oblique to the axis of revolution, revolve both in the same direction. The metal of the surface of the bar thus acquires an increased motion in a spiral direction, and is drawn over its core, receiving, consequently, the form of a pipe. The pipe moves spirally forward, and the metal becomes still denser as its parts are spirally pushed and pressed. Much importance is attached to the spiral arrangement of the metal, apart from the advantage the tubes possess in presenting no lines of welding. The thickness of the pipe may be varied within wide limits from a bore of  $\frac{1}{16}$ th inch, and an outside diameter of  $1\frac{1}{2}$  inch to a bore 95 per cent. of the outside diameter. Whilst the description mentions only iron pipes as having been made, we presume, from the thin tubes above referred to, that the process is applicable to other metals.

### ELECTRICAL MINERS' LAMPS.

THE numbers and varieties of these lamps, which are continually springing up, is becoming legion, and one after another they drop into oblivion through having utterly failed to substantiate the claims that are made for them. One may generally judge of the value of these inventions by noting certain of the claims made for the information of the public, whom it is hoped to deeply interest in the matter to the financial benefit of the promoters. At the *Inventors' Institute* recently, a paper "of much interest" was read by Messrs. Gauzentes and Strong, on "A New Miner's Lamp and Primary Battery," the invention of the former gentleman. The following are some of the claims: "The metal which serves for the anode of energy is refined by a new and simple process, and allows us to obtain the maximum production of current without fear of rapid polarisation, which has up to the present proved the great obstacle to the employment of a direct source of electricity." This is the first time we have heard that polarisation took place at the anode of a battery; we were always under the impression that it took place at the cathode, but we stand corrected. The new fluid "can be manipulated without the slightest danger;" other fluids, of course, have proved highly dangerous, and have caused serious accidents, and no primary battery has in consequence been successful before the marvellous invention of M. Gauzentes was brought out. "Total suppression of all local resistance"—wonderful! The battery is guaranteed to last for five years; we wish the undertakers joy if they imagine that such a thing is possible. Cost of maintenance—5d. per 72 to 80 hours, all charges included; candle-power of lamp =  $\frac{3}{4}$ ; we have heard this sort of thing before. A portable table-lamp is stated to give "the happiest results," both as regards "immunity from fire and cheapness." Who that has seen electric table-lamps has not been struck by the absurd disproportion between the size of the lamp and the candle-power emitted. This has always been the case, and we venture to think is likely to continue to be so for some time to come. We do not mean to say that there are not very good points in the invention of M. Gauzentes. There are no indications as yet one way or the other; we have only assertions; but why bolster up what may be a good thing by absurdities? We fear, however, that M. Gauzentes has not made much advance on his plans of several years ago.

THE letter of the Chelsea Electricity Supply Company to the Vestry giving notice of its intention to discontinue the supply of electricity between the hours of midnight and four o'clock in the afternoon, in consequence of the fog, is, we think, a grave error. Although only a temporary measure, it seems to give more than a local colouring to the complaints which have recently been directed against this unfortunate company, and Mr. R. Chamberlain will now have additional arguments to support his contention that it cannot carry out its compact with its customers. To cut off light when it is most wanted seems to be a *reductio ad absurdum* of the most childish nature, and we can only think that the grounds for the complaints of Mr. Chamberlain and others are stronger than we had thought.

The Chelsea Company  
again.

## ON STANDARD WIRE RESISTANCES.

AT the recent meeting of the American Institute of Electrical Engineers a most interesting report was received from the Standard Wiring Table Committee dealing with its researches into the experiments made to determine the resistance of copper. We give the report as it was received, although it has since been somewhat modified by action of the institute in taking the soft copper standard mentioned instead of the hard copper standard.

*Preliminary Report of the Standard Wiring Table Committee in Regard to Matthiessen's Standard of Resistance of Copper.*

The council of this institute, at its regular monthly meeting, held December 3rd, 1889, appointed a committee "to formulate and submit for approval a standard wiring table for lighting and power purposes." The committee appointed consists of the following members of the institute: Thomas P. Conant, Dr. Louis Duncan, Prof. Wm. E. Geyer, A. E. Kennelly, George B. Prescott, jun., E. Wilbur Rice, jun., Prof. E. P. Roberts, Prof. Harris, J. Ryan, William Stanley, jun., Dr. Schuyler S. Wheeler, and Francis B. Crocker, chairman. This action was taken by the council with the object of overcoming, or reducing the great confusion which now exists in regard to the standards and constants of electric conductors.

At the first meeting of the committee, held January 10th, 1890, it was decided to confine the work at first to the three subjects of standard of resistance, temperature coefficient, and safe carrying capacity of copper, since these are of fundamental importance.

The subject of Matthiessen's standard alone is so confused and involved, and the discrepancies are so great between the best authorities that the committee has devoted its attention almost entirely to this subject up to the present time. After a very thorough investigation of Matthiessen's work with a view to ascertaining what his standard really was, by a sub-committee, consisting of Prof. Wm. E. Geyer, Mr. George B. Prescott, jun., and the chairman, the conclusion has been reached that Matthiessen's "mile standard" (one statute mile of pure copper wire one-sixteenth inch in diameter has resistance of 13.59 B.A. units at 15.5 degrees C.) is not the true one, although very commonly used. We consider the correct Matthiessen's standard, and the one in which he himself had most confidence, was the "metre-gramme" standard (resistance of pure hard-drawn copper wire, one metre long, weighing one gramme = .1469 B.A. units at 0 degrees C.). This has the disadvantage that it is expressed in terms of weight instead of diameter. It is, however, very much more difficult to get the exact mean diameter of a wire than to get its exact weight, as Matthiessen himself states. Furthermore, by selecting the most reliable constants given by Matthiessen, and corroborated by investigation and correspondence with the best authorities, we have, by calculation, converted this "metre-gramme" standard into a standard referred to dimensions and independent of weight, which is the form generally used. The various constants selected, the method of calculation, and the values deduced, are given in a table at the end of this report.

As to the fact that wires may be found which test 102 per cent of Matthiessen's standard, or even higher, we are of the opinion that this is no real objection, provided the value of the standard is definite and generally accepted. A standard which is not the highest attainable value may be even considered an advantage, since the average commercial wires will approximate to it more closely.

Although we believe the standard we recommend will answer the purpose temporarily, and probably permanently, nevertheless we think that if a thoroughly correct and complete redetermination of the standard resistance of copper could be accomplished it would be a benefit to electrical science and industry. Favourable

offers in this direction have already been received by the committee from the John Hopkins University, Cornell University, and Columbia College, and it is very likely that this redetermination may be undertaken.

This committee purposes next to take up the subject of the safe carrying capacity of wires. Matthiessen's standard recommended by this committee is: A hard-drawn copper wire one metre long, weighing one gramme ("metre-gramme"), having a resistance of .1469 B.A. units at temperature of 0 degrees C.\* From this standard we calculate, by taking the value 8.89 for the specific gravity of copper, that a hard-drawn wire one metre long and one millimetre in diameter ("metre-millimetre") has a resistance of .02104 B.A. units at 0 degrees C. This value is also given by Matthiessen.† Matthiessen's figures‡ for relative conducting powers are: Silver, 100; hard or unannealed copper, 99.95; soft or annealed copper, 102.21.

From these the resistance of hard copper is found to be 1.0226 times that of soft copper; therefore, the resistance of a soft copper wire one metre long and one millimetre diameter is .02057 B.A. units at 0 degrees C. From this the resistance of one cubic centimetre of soft copper is found to be .000001616 B.A. units at 0 degrees C. And the resistance of soft copper wire one foot long and .001 inch in diameter (mil-foot) is 9.720 B.A. units at 0 degrees C. Taking one B.A. unit as .9889 legal ohm, any of the above values may be converted into legal ohms. To find the conductivity of copper at temperatures other than 0 degrees C., Matthiessen's formula may be used:—

$$C_t = C_0 (1 - .00387 t + .000009009 t^2).$$

*Table of Values Based upon Matthiessen's Correct Standard.*

	B.A. units. 0° C.	Legal ohms. 0° C.
Matthiessen's standard metre-gramme, hard ...	.1469	.1453
Metre-gramme, soft ...	.1436	.1420
Metre-millimetre, hard ...	.02104	.02080
Metre-millimetre, soft ...	.02057	.02034
Cubic centimetre, hard ...	.000001652	.000001634
Cubic centimetre, soft ...	.0000001616	.000001598
Mil-foot, hard ...	9.940	9.829
Mil-foot, soft ...	9.720	9.612

Specific resistance of hard copper (1 cu. cent.) = 1634 (C.G.S. units).

Specific resistance of soft copper (1 cu. cent.) = 1598 (C.G.S. units).

Matthiessen's standard specific gravity of hard copper, 8.89.

Resistance of hard copper is 1.0226 times that of soft copper.

Resistance of soft copper is .9779 times that of hard copper.

Legal ohm is equal to .0112 B.A. units.

B.A. unit is equal to .9889 legal ohms.

After reading the report, Prof. Crocker, the chairman, added the following very interesting details concerning the practical side of the resistance question, and the information that he had been able to obtain as to the classical experiments on which our present standard is based. Prof. CROCKER said:—

"Of course, the derived values follow as soon as the fundamental standard is decided on, and the question, therefore, is, not what the derivations are, but whether the fundamental standard is correct; in other words, whether Matthiessen's 'mile standard' or Matthiessen's 'metre-gramme' standard is the more reliable. Now, the sub-committee has investigated this particular point with a great deal of care, and arrived at a very definite conclusion—that the metre-gramme standard was unquestionably the more accurate and the more reliable of the two, and that Matthiessen himself so considered it. Fortunately, after having decided this, we received a letter from Mr. Latimer Clark, who is one of the best authorities on this matter, and who was a contemporary of Dr. Matthiessen, in fact, he suggested to Dr. Matthiessen that he should undertake these experiments, so he is

\* *Philosophical Magazine*, May, 1865.

† *Philosophical Magazine*, May, 1865.

‡ *Philosophical Transactions*, 1864.

specially competent to express an opinion on this subject, and he agreed with our conclusions in every respect. We had already arrived at these conclusions, so his letter was simply corroborative. Mr. Latimer Clark's letter to the committee covered the subject very thoroughly and clearly, and I wish here to express our thanks to him for his kindness. There is, however, considerable confidence in the mile standard, and I think that it is simply that it has been used, and the fact that a mile and a sixteenth of an inch are more familiar values for the ordinary American and English engineer than a metre and a gramme, but the metre-gramme is just as capable of being transformed into practicable and common units as the mile and sixteenth of an inch. The necessity for deciding on some standard is more urgent than would be ordinarily supposed. This morning, for instance, in my ordinary professional work, I referred to two wiring tables issued by presumably competent persons, and both intended to be correct, and both being such as an engineer would use in his practice. One of these tables gave the resistance of No. 25 B. & S. gauge copper wire as 33.4 ohms per lb. at 75° Fahrenheit. The other gave it as 34.7 ohms per lb. at the same temperature. Now, there is a difference of 1.3 ohms in 33 ohms, which is about 4 per cent. In some cases it does not make very much difference whether it is 4 per cent. one way or the other, but 4 per cent. is a very considerable discrepancy, and in a great many cases it would make a very serious difference. For instance, I was figuring on 16 lbs. of wire, and it made a difference of almost 21 ohms. That is not only measurable, but it is a serious matter in some cases. I think that when two wiring tables that electrical engineers ordinarily use differ by 4 per cent., it is time to do something. I just happened to pick up these tables this morning. I did not do so with reference to this subject. I dare say if I looked for discrepancies I could find much greater ones. The adoption of this standard does not mean that every wire used for commercial purposes shall be 100 per cent. of Matthiessen's standard. There is no reason why an electrical engineer in his specifications should not require 101 per cent. if he considers it necessary, and I can think of cases where it might be necessary. On the other hand, it might be sufficient if the conductivity was 97 or 98 per cent. of the standard. It is simply necessary that we should have some definite value.

"The question whether any standard at all is necessary is a more important one; as it is not absolutely necessary to have a standard. We could simply say that one mil-foot or one cubic centimetre of the copper used for a certain purpose should have such and such resistance—in other words a certain specific resistance. But practical men have become accustomed to using Matthiessen's standard, and they seem to want a standard, and they will use one whether we want them to or not; such being the case I think it better to decide what Matthiessen's standard is. It certainly is commonly used. You see the expression in every book and almost every paper and specification, and as it now has no definite value—even though it is not used in the future, just simply to have it settled once and for all, I think it would be well to settle upon a definite standard. We feel sure that the institute will make no mistake in adopting this as Matthiessen's standard, and unless there is some particular objection to it which has not been brought out by our investigations, we hope the institute will do so."

Mr. Geo. B. Prescott, Jun., then added some further details of the committee's investigations and made the suggestion, which has since been followed, of taking the soft copper standard in preference to the hard. Mr. PRESCOTT said: "In making this report the committee has not thought it necessary to go into detail very much, and it may be interesting to members of the institute to know how this discrepancy in what is called Matthiessen's standard has arisen. In the first place, it is perhaps worth while to inquire why this standard was adopted in preference to any other. The reason was because Dr. Matthiessen made a series of

careful experiments to determine the resistance of metals and the variation of their resistance with changes in temperature, which extended over a great number of years and formed the basis of the work of the British Association, which decided on the practical standards. It seems that years before this British Association Committee undertook this labour various standards of resistance had been proposed by German, French and English electricians, and they were of all kinds, and among them was one proposed by Dr. Matthiessen, which was this 'standard mile.' There were no ohms in those days, and he made up a standard mile of this copper, and that was used as a unit in England for a long time. Later on, when the committee of the British Association had determined the value of the ohm in absolute units and had prepared practical standards, part of this committee tested the different standards that had been made in different parts of the world, including this standard of Matthiessen, and when they measured it they found that it was equal to 13.59 British Association ohms. Matthiessen never gave it that value; it was simply an arbitrary standard that he selected, because it was a convenient unit. Probably it was the size of wire commonly used in those days, so that really it never was a standard except in that sense. After Matthiessen's work was completed and published, Dr. Fleeming Jenkin, who was the secretary of the association, tabulated the results. Matthiessen's measurements were made with respect to weight and length, and also diameter and length. But his measurements of diameter were always very unsatisfactory, and finally the only measurements that he really relied on were those of length and weight. But he made a very great mistake, which he himself acknowledges in his reports, which was that he neglected to take the specific gravity of the actual samples that he experimented on, and the result, of course, is easily understood. Every sample of copper varies somewhat in its physical properties, and if you were to take one hundred samples of wire, and measure their resistances at a given weight and length, and then attempt to calculate the resistance from the cubical dimensions, you would find a difference, simply because there is a difference in the drawing of wires which changes their molecular constitution. Dr. Matthiessen neglected to take the specific gravity of any sample of wire that he tested, and the result is that we do not know to-day what Matthiessen's standard is, except in terms of weight and length.

"A further complication arose in this way, that Dr. Fleeming Jenkin, who, as I say, tabulated the results which Dr. Matthiessen obtained, made all sorts of derivations, giving the resistances in foot-grains and foot-mils, and metre-grammes and metre-millimetres—all by calculation. Of course, in converting from length and weight into length and diameter, he had to use specific gravity. He selected certain specific gravities. In his original table there are errors. Those errors have been copied. Other people have calculated tables from the standard mil unit, and, of course, they give different results, so when Matthiessen's standard is referred to to-day, there is a great deal of uncertainty as to which standard is meant. As a matter of fact, the statute mile standard is probably nearer the true resistance than the metre-gramme, for the reason that it gives a higher conductivity, and there have been any number of cases of wire being tested that had greater than 100 per cent. conductivity, and it was for this reason that seven or eight years ago I calculated a wire table, and selected this unit of Matthiessen's simply because it was the lowest, and agreed with some results that I had actually obtained."

Mr. GEORGE C. GROWER said: "I think there is a mistake made when hard copper wire is assumed as the standard and the resistance of soft copper reckoned from it. This takes for granted that there is a fixed ratio in resistance between hard and soft copper. But this ratio depends entirely upon the hardness of the hard copper compared with the soft. For instance, if you take large copper wire and have it as hard as you can get it, the conductivity would be almost as good as

soft copper, while in a small wire it would not be nearly so good. I have had as much as 8 per cent. difference between hard and soft copper made out of exactly the same stock on small wires. If we should make the wire very small, I dare say it would make still more difference.

"I agree with the committee that the metre-gramme standard is the more reliable, because whenever I have tried to make tests with diameter I could not get any sort of agreement among them; but where I take soft copper standard, no matter what the size of the copper is or anything else, so long as it is soft copper and from the same stock, I get almost the same result. But if you take hard copper for the tests, the tests will differ several per cent., according to the size of the copper. I think, for that reason, the standard should be of soft copper of a given length and weight."

Mr. CROCKER said: "It is perfectly correct as an abstract statement that soft copper is more constant in its resistance than hard copper. Hard copper can be made of almost any resistance up to several per cent. above soft copper. But soft copper is not Matthiessen's standard; it is precisely like the case of the foot. The English foot originally, I have heard, was the length of the King's foot. Well, now, at the present day, I think it is a little in excess of the average length of the human foot. But it does not make a particle of difference, providing it has a definite value, as it has, and providing a correct copy of the standard is kept in a safe place—it does not make any difference whether it is an inch longer or an inch shorter than the human foot. It has a definite value, and no one, I think, at the present time, would recommend changing the English foot, as a unit of measurement, to agree more closely with the length of the anatomical English foot. It is precisely the same with Matthiessen's standard. Unfortunately or fortunately, as you may look upon it, Matthiessen has promulgated a standard, and it has been largely, in fact almost universally accepted. Now all that is necessary is to adopt a definite value for this standard. It does not make much difference what it is, provided it is definite and generally accepted. Of course, in selecting a definite value, we want to select the best one, the most reliable one, the one that he himself considered most reliable, and the one that other authorities deem the best. So it seems to me that the mere fact that one standard or another approximates more closely to what the highest possible value is, or the fact that one or the other happens to be easier to determine in practice, makes no great difference, provided we get a certain definite standard or resistance for various lengths, weights, diameters, and kinds of copper. I think that all that is necessary is to free this subject from its great confusion by simply adopting a definite standard, and if that standard happens to be more correct than some other, so much the better; but even if it is not, it is very much better than confusion."

It is to be hoped that this report of the Standard Wiring Table Committee will receive the attention it deserves, as it certainly has gone far to straighten out the complex tangle into which some careless copying of constants has led. The report is both a judicious one and worthy of receiving general adoption.

## RESEARCHES IN THERMO-ELECTRICITY.\*

By Messrs. CHASSAGNY and H. ABRAHAM.

WE have already shown † that the electromotive forces of thermo-electric couples, the junctions of which are kept at 0° and 100°, may be determined within  $\frac{1}{10000}$ th of their value.

We must observe that when, as in our experiments, the equilibrium of electromotive forces is shown by a galvanometer of low resistance, this degree of accu-

racy is retained for the lesser electromotive forces given by these couples at the intermediate temperatures; the resistance introduced into the circuit of the galvanometer diminishing with the electromotive force to be measured, the absolute sensibility of the instrument increases, and the relative accuracy of the measurements thus remains almost constant.

We see, then, that thermo-electric couples employed as thermometers for registering very minute variations of temperature show the hundredth part of a degree between 0° and 100°, and they have this advantage over the ordinary thermometers that the smaller the variation of temperature is, the more accurately is it indicated.

In order to find the relation between the electromotive forces of the iron-copper couple and the scale of temperatures of the hydrogen thermometer, we measured these electromotive forces at different temperatures between 0° and 100°, one of the junctions being in ice, and the other in a bath of water stirred continually and placed in a regulating stove.

A thermometer placed beside the joint shows at each moment the temperature of the bath. The thermometer is of toughened glass, and was supplied by M. Tounelot, and the readings taken on this instrument were corrected and reduced to the scale of the hydrogen thermometer by means of the tables published by the International Bureau of Weights and Measures, where this subject has been studied.

We found, moreover, that the indications of this thermometer and those of a second thermometer of the same type, placed in the same bath, in no instance differed from one another to the extent of  $\frac{1}{100}$ th of a degree. The temperature of the baths varied very slowly, and these slight variations were indicated almost simultaneously by the thermometer and by the thermo-electric couple, the latter, however, always acting first.

A parabolic formula of two terms is quite incapable of showing the relation between the electromotive forces and the corresponding temperatures of the hydrogen thermometer, the discrepancies between the temperatures calculated by means of such a formula for 50° and 100° and the temperatures actually observed, amounting to +.12 of a degree at 25° and −.13 of a degree at about 75°. The following empirical formula, although still not representing the measurements with absolute accuracy, will give their values within  $\frac{1}{100}$ th of a degree, between 0° and 100°.

$$E_0^t = \frac{at + bt^2 + ct^3}{t + 273},$$

$$a = 10^{-3} \cdot 3.56604$$

$$b = 10^{-6} \cdot 8.3827$$

$$c = 10^{-8} \cdot 3.265$$

as shown by the following figures, taken from the same experiments:—

Value of  $E_0^{100} = .0010932$  of a volt.

Temperatures.	Electromotive forces.	
	Observed volts.	Calculated volts.
65.13°	.0007656	.0007654
32.49°	.0004043	.0004045
15.48°	.0001981	.0001980*

\* Experiments performed at the higher Ecole Normale.

**Dangers of Electric Wires.**—Last Thursday while six horses were drawing a snow-plough along the streets of Portland, Maine, they came into contact with a broken electric wire and three were killed instantaneously.

\* Comptes Rendus, November 17th, 1890.

† Comptes Rendus, vol. cxi., pp. 477 and 602; 1890.

## THE OHIO STATE TRAMWAY ASSOCIATION.

THE opportunities for American electrical engineers to ventilate their ideas are quite in keeping with the general progress of the science. Not only do our American friends institute a number of "Conventions," purely electrical in their aims, besides attending the usual and frequent meetings of electrical societies and clubs, but they are now thoroughly invading the conclaves of tramway men, who, by force of circumstances, are all becoming amateur electricians and staunch supporters of the new motor. The Ohio State Tramway Association held its ninth annual meeting at Columbus, O., November 19th, when the President invited representatives of several electrical firms to describe to members the special features and advantages of each system. No papers were offered or read, but Mr. C. K. Harding, of the Harding Electric Railway Company, Atlantic, Iowa, opened the discussion by making reference to underground systems of distribution, in which, he regretted, the foreigner had taken the lead up to the present. The speaker passed on to a criticism upon overhead conductors, objecting to the unsightliness of wires and poles, the danger to other wires, interference with telephones, liability to damage from lightning, and the comparatively low voltage adopted, which is necessary for the safety of animate beings, but which does not offer the greatest economy and efficiency for distribution over large areas. In order to avoid these difficulties, Mr. Harding devised a closed conduit system which savours very much of inventions brought out in England at various periods. The following is the speaker's own description:—It should be understood that to preserve insulation you must exclude water, and to do that the conduit must be entirely closed, without slot or other opening through which the current is taken. In order to accomplish this result, I employ a tubular iron casing, in the top of which is a channel or flanged portion in which are insulated and supported the sections of the working conductor. These sections may be from 4 to 6 feet long, and extend an eighth of an inch above the surface, and are normally insulated from each other, the casing and the main conductor, which extends through the lower tubular part, and is entirely surrounded and embedded in the insulating material. In the end of each section of the casing or conduit there is an enlargement of the lower tube, which forms a junction box in which is located a small electro-magnetic contact, making a device which, when operated, connects its conductor section with the main or supply conductor. One end of the winding on the magnets of these contact devices is connected through a simple switch to the adjacent working conductor section, and the other end directly to the conductor section on the other side by means of this arrangement, and a second brush on the car. I employ a very small portion of the current to operate automatically the contact device, and bring the exposed sections of working conductor separately and successively into connection with the main insulated supply conductor when these sections are immediately under the car and protected by it. In other words, I get the current to the car through the series of insulated exposed sections which are fed from the main conductor as the car passes along, and are at all other times completely insulated from the wire carrying the current. By employing a derived circuit in multiple arc with the motor circuit, I am enabled to use a very small portion of the main current for the operation on the contact devices, and to make the magnets of small size and wind them with iron wire, thus making the construction of the contact-making devices a comparatively simple matter, and permitting them to be placed in a small closed cavity in the ends of the sections, where they will be readily accessible and interchangeable."

Mr. Curtiss, of the Short Electric Railway Company, stated that the greatest objection to electric railroading in its practical operation has been the one item of repairs. In one town, he was told by a gentleman con-

nected with the road, that the repairs last year amounted to \$1,100 per car. The Muskegon (Mich.) road, constructed by the Short Company, had been running for six months, commencing with five cars, and increasing to nine, but the repairs had not exceeded \$100 on all the electrical equipment.

Mr. C. A. Benton, of the Detroit Electrical Works, assured the audience that his firm had 21 cars running at Saginaw (Mich.), which have been in operation for 11 months, and the cost of repairs had not reached the sum of \$50.

Mr. W. J. Cooke, of the McGuire Manufacturing Company, advocated heavy trucks carrying electric motors, and he maintains that most of the trucks built at the present day were far too light, therefore not sufficiently strong. He did not mind carrying 1,500 lbs. in addition to what is the usual practice. Mr. Cooke also spoke of an electric heater, consisting of a ribbon running along the edge of the seat. The temperature can be varied to any degree by the driver who commands the switch which conveys the current from the trolley wire to the heater.

Mr. Bronnell, of the Bronnell Car Company, also dwelt upon constructive details of the cars. In most of the electric trucks the motors are located very close to the ground, underneath the car, which makes repairs very difficult, and involves laying up the vehicle during repairs to motors. It would seem that the better mode would be the use of a separate motor car of simple construction propelling the passenger car—in other words, he is in favour of electric locomotives.

## BRANLY'S EXPERIMENTS ON THE VARIATION OF CONDUCTIVITY UNDER DIFFERENT ELECTRICAL INFLUENCES.

AT a meeting of the Paris Academy of Science, held on November 24th, Monsieur Edouard Branly read a paper, in which he described some experiments upon the variations of conductivity observed in their metallic layers when subjected to electrical influences.

The layers of metal were prepared by spreading metallic dust upon a plate of ground glass or ebonite of dimensions 7 cm.  $\times$  2 cm., and then polishing with a burnisher. In the case of copper, a little tin was added to facilitate adherence. Such a layer is capable of a resistance which may vary from several ohms to several millions for the same weight of metal.

If a circuit be formed containing one of these prepared layers, a high resistance galvanometer, and a Daniell cell, only a very insignificant current is able to pass. An abrupt diminution of resistance, accompanied by a marked deviation on the galvanometer, is exhibited when electric discharges are produced in the neighbourhood of the circuit by the action of a small Wimshurst machine or a Ruhmkorff coil. This effect diminishes when the distance of the losses of discharge is increased; but it is easily observed, without special precautions when the distance is increased to several metres. By making use of a Wheatstone's bridge, it has been observed when the distance has been 20 metres.

Besides the behaviour of a thin layer of copper, that of similar layers of iron, aluminium, antimony, cadmium, zinc, bismuth, and several other metals were examined.

Check experiments were devised by Branly, and carried out, in which a capillary electrometer played an important part; but the results were in every respect confirmed.

Branly has examined the condition necessary to produce the observed phenomena, and with the following results:

It is not necessary that the circuit be closed, but the diminution of resistance is best produced if the metallic layer is bound by its extremities to the conducting wires.

The passage of an induced current through the layer

produces the same effect as that of a discharge in its neighbourhood.

When working with continuous currents, the passage of a strong current renders the metallic layer better able to transmit a full current.

The best results were obtained when, in these experiments, were substituted for the plate of glass and ebonite covered with metallic layers; what M. Branly calls "tubes à limailles," that is, tubes of glass or ebonite which have been treated with fine metallic filings mixed with some non-conducting liquid.

## THE ELECTRIC LIGHT IN AGRICULTURE.

[FROM A CORRESPONDENT.]

IN Hungary, where, until very lately, agriculture was almost the exclusive employment of the majority of the population, the electric light met with its earliest application in agriculture. It was used to thresh out the grain by night by means of movable light apparatus, driven by the locomotive of the steam threshing machine, in order to complete the threshing more quickly on large farms. Strangely enough, however, this arrangement, in spite of its great convenience, has still met with only a relatively small application. Baron von Steiger Münsingen has therefore taken the trouble to explain the advantages of threshing by the electric light on the basis of actual figures as obtained from his own practical experience. I think that I shall do many of your readers a service if I give the facts a wider circulation through the medium of your valued paper.

Where the farmer is limited to a certain number of labourers, and cannot procure more, it is no small convenience if they can be rendered available for other duties by a more rapid completion of the threshing. The economy of fuel is not to be despised, as the consumption is considerably less if the boiler is kept constantly hot than if it is let cool down, and steam has to be got up afresh every morning.

Night work is particularly advantageous for the possessor of threshing machinery, which can be hired out, as the machine can thus, in a single season, earn half as much more hire.

Much of this advantage can indeed be also secured by using more powerful machinery. But we must not forget, *e.g.*, an eight horse-power machine costs more than ten times as much as a lighting installation such as is needed for threshing.

In the work this season there was used an 8 H.P. threshing machine by Clayton and Shuttleworth, which had already served for eight seasons. The illuminating installation consisted of a dynamo, an arc light (in a bye-circuit) of 800 normal candles and their accompanying fittings. The cost of the entire installation, including the cart built at home, was 500 florins.

The first question was whether the engine, whilst working the threshing machine at full power, could supply at the same time the necessary power for the dynamo. My anxiety proved quite needless, as the requisite 1,400 rotations of the dynamo were obtained with the utmost ease without any higher pressure of steam. The engine, therefore, whilst working the threshing machine, had still a larger excess of power than was needed for the production of light.

The electric light installation connected with the threshing engine has been in action on my estate for 206 hours in 32 nights, or an average of 6.43 hours per night. The whole work effected this season in 922 hours was 751,900 kilos., or an hourly average of 815 kilos. Of this total there were obtained in 716 hours of daylight 589,000 kilos. or 822 kilos. hourly, and in 206 hours in the night by the electric light 162,900 kilos., or 790 kilos. hourly.

The ordinary hours of work in threshing begin at 5 a.m. and last, with half an hour off for breakfast, an hour at noon, and half an hour (time not stated), till 8 p.m., or 13 hours, which I may call a normal thresh-

ing day. If calculated into such days, the performance of the above-named plant would be 55.07 normal days by daylight, and 15.85 normal days by electric light, with an average result of 10.602 kilos. per normal day. Including Sundays and holidays, time lost by bad weather, removing the machinery, &c., there was a clear saving of three weeks effected by the use of the electric light.

If we suppose a constant light installation, working without disturbance, which is quite practicable, the proportion of the night work to the day work comes out more favourable. We have taken the normal day at 13 hours (from 5 a.m. to 8 p.m.). The night work from 8 p.m. to 5 a.m., is 9 hours, from which  $1\frac{1}{2}$  hour has to be deducted for lubrication and other stoppages, so that there remain  $7\frac{1}{2}$  hours of night work.

On using the night for threshing, changing the workmen of course at noon and midnight, the effective time for work would come to  $20\frac{1}{2}$  hours per calendar day of 24 hours. Of these, on account of the short summer nights, 6 hours would be by electric light and  $14\frac{1}{2}$  hours by daylight. The resulting gain of  $1\frac{1}{2}$  hour of daylight work results from the relay of workmen. We know that the average yield of an hour by night is 790 kilos., and that of an hour by day 822 kilos., so that the total yield of an 8-H.P. installation will be 16,659 kilos. per calendar day, as against 10,602 by daylight only.

Taking the present total yield of 751,900 kilos. of the above described installation as a datum, it appears that a threshing season of 45 calendar days, with the aid of the electric light, is equal to 71 calendar days with daylight alone. Hence, in the present case, there is the important economy of 26 days, or, in round numbers, a month.

As regards the remunerating character of the process, the author does not indulge in hypotheses of a threshing season without drawbacks, but takes the figures as resulting from this season's work, though it took place under unfavourable circumstances.

On the whole, 162,000 kilos. were actually threshed out by the electric light. If, in order to effect the work in the same time, this quantity had been threshed with a hired plant, it would have cost, on the usual hire of 4 per cent. in kind of the threshed grain, 6,516 kilos., or at the average price of 7 florins per metric cwt. on all the grain, 456.12 florins. Fuel and lubricants are not taken into account, as they remain substantially the same, whether the plant works without intermission, or if two work simultaneously. The lubrication for the dynamo has to be taken into account, as also the carbon rods, and the sinking fund for the lighting plant.

The consumption of lubricants for the dynamo for the entire 206 hours was  $1\frac{1}{2}$  kilo. of oil, of the value of 63 kreuzer. A pair of carbon rods, lasting 10 hours, cost 22 kreuzer, or per hour 2.2 kreuzer, or per metric cwt. 0.27 kreuzer, or for the entire season 4.53 florins.

As for the sinking fund, it may be reckoned in two manners. We may place the cost price of the installation of 500 florins opposite to the 450 florins earned by a hired installation. Next year, therefore, the plant would only have to earn 50 florins, and it would then work gratuitously, with the exception of the trifling cost for carbons and oil.

Or we may deduct from the cost price 20 per cent. sinking fund, and 5 per cent. interest, or, together, 125 florins.

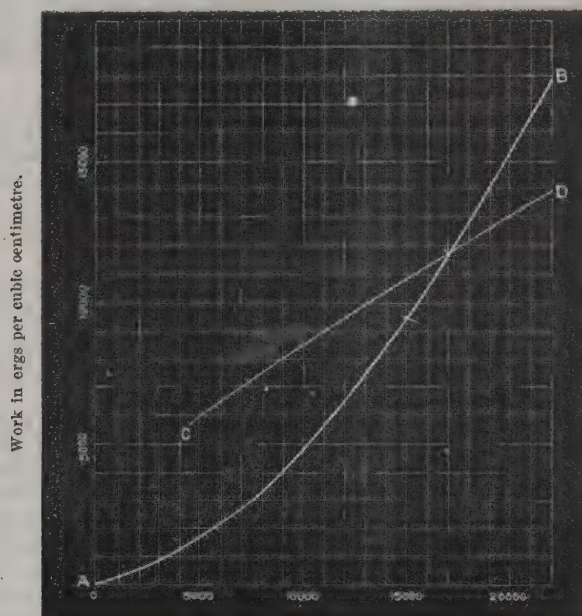
**Breakdown of Telegraphic Arrangements.**—Lord Salisbury was the victim of a breakdown in the telegraphic arrangements while delivering his speech at Waterfoot some days ago. The room in which the telegraphic apparatus was situated appeared suitable at first, but after the gas and stoves had been lighted it became so damp that the perforated paper ribbon used to work the Wheatstone automatic apparatus was rendered useless. So soon, however, as it became evident that the apparatus was unworkable arrangements were made for the report to be transmitted partly by hand signalling and partly by train to Manchester.

A SYNTHETIC STUDY OF DYNAMO  
MACHINES.

(Concluded from page 546.)

## X.—WORKING INDUCTION.

THE curve, A, B, in fig. 150, shows the work expended in carrying each cubic centimetre of the armature iron through a complete magnetic cycle at different degrees of induction, as explained in a previous article (p. 356). At first sight it might be imagined that a considerable benefit is to be derived from having a low working induction, but it must not be forgotten that for a machine of specified output, a low induction means a nearly proportional increase in the mass of iron in the armature. Taking a Gramme machine with the armature core pressed up to the usual induction of 17,000 C.G.S. per square centimetre, the ordinate to the curve, A, B, at the point represented by 17,000 on the line of



Induction per square centimetre.

FIG. 150.

abscissæ may be taken as representing the work done in magnetising and demagnetising the armature. If the radial depth of the armature core were doubled, the induction would be only 8,500, and the weight of iron would be nearly doubled, the exact increase of the latter depending, of course, on the relation of the radial depth to the diameter. However, assume it doubled for the sake of argument, and the curve, C, D, shows the energy expended for different degrees of induction. The lines cross at 17,000, as this is the normal induction for Gramme machines, C, D being drawn with the object of comparing the expenditure of energy for higher and lower working inductions with that at the normal. To draw this curve, all the ordinates of A, B are multiplied by the ratio of 17,000 to the induction for which they represent the energy expended, the assumption being made, as above stated, that the mass of iron is inversely as the induction. It will be observed that though the work expended per cubic centimetre for an induction of 8,500 C.G.S. is only 3,700 ergs as against 11,800 ergs for an induction of 17,000, the amounts of work expended for 8,500 and 17,000 respectively in armatures for similar outputs stand in the ratio of 7,500 to 11,800. It will also be noticed that for any given output there is only about 8 per cent. more power wasted in hysteresis at an induction of 17,000 than at 15,000.

This last statement shows that, for cylinder arma-

tures not much is to be gained by reducing the induction from the first to the second figure, while there is certainly something to be lost. If the radial depth of an armature is increased, it requires more wire to go round the core, which, consequently, has a higher resistance, while for series arc lighting, for which this class of machine is eminently suited, the armature becomes, by reason of the low induction, useless. For arc-lighting the armature should have an induction higher, if possible, than 17,000—in fact, the higher the better, since one of the essentials for good working is that the characteristic shall drop considerably in the vicinity of the working current, and that a relation shall be established between current and difference of potentials such that as the former increases the latter diminishes, and *vice versa*. In four-pole Gramme machines it is usual to employ a working induction of about 14,000 C.G.S. per square centimetre.

In armatures wound on the drum or Siemens principle, it is usual to work at an induction of from 13,000 to 14,000 C.G.S. if ample means of ventilation are provided. Where no means of ventilation exist, and the whole of the heat has to be got rid of by radiation from the external surface, the working induction is generally from 10,000 to 12,000. Here, for a machine of given output, it is obviously of no advantage to increase the induction, while something is gained by keeping it low. The diameter of the armature being settled with reference to the number and size of conductors, there is nothing, save as regards weight, to be gained by cutting away the interior of the plates. On the contrary, by making the central opening as small as possible, there is a reduction in the loss due to hysteresis, the magnetising force required for the armature is smaller, and these advantages are not counterbalanced, as in the case of cylinder armatures, by any increase in the resistance of the conductors. In machines of the drum type, having more than two poles, the interior opening in the armature core allows of good ventilation, and accordingly the working induction is generally between 13,000 and 14,000—very often the latter.

As regards the induction in the air gap, generally it will be found that this is very similar for both cylinder and drum machines averaging from 5,000 to 6,000 C.G.S. per square centimetre, though occasionally rising in the drum type of machine to 7,000. The number of ampère-turns which can be carried by the armature consistent with freedom from sparking, as influenced by the induction in the air gap and its dimensions, has been already discussed.

The induction in the magnets varies considerably in different types of machine. For annealed wrought iron forged bars 15,000 is usual, while in cast iron the induction is very much less, being generally from 7,500 to 8,000. Of the total lines of force which pass through the cross section of the magnets where the flux is greatest, only from 70 to 80 per cent. are utilised, the remainder choosing a path of their own outside the armature, and constituting a waste field. The magnitude of this field depends on the design of the machine, and the circumstances influencing it have been already discussed.

In penning these articles, an attempt has been made to place before our readers the latest considerations respecting dynamo designing. While we have been publishing them many important papers on dynamo construction have appeared, while several new designs of machines have been described and illustrated in our columns. Necessarily the simultaneous publication of these has narrowed to some extent the scope originally proposed for these articles, but that a large amount of ground has been gone over will be readily admitted by those of our readers who have followed the papers from the beginning. The one section which has not received attention in the present series, namely the regulation of machines, we find it advisable to postpone for the present, partially influenced by the above reason. But we trust that so far as we have gone our efforts have not been without benefit to our readers.

## AN ELECTRICAL LOAD EQUALISER.\*

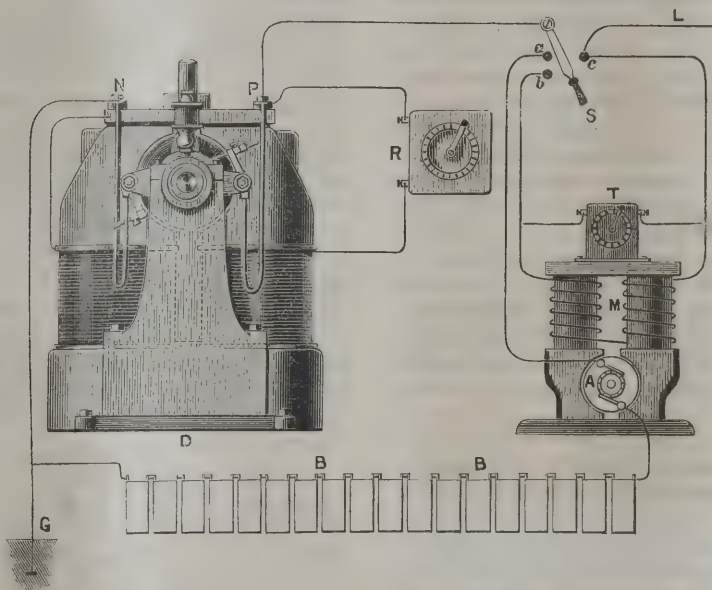
By C. O. MAILLOUX.

THE task allotted to the steam engine in electric railway work is not an easy one. It would indeed be difficult to contrive a more crucial test than such work affords of the regulating qualities and mechanical endurance of an engine. The load is incessantly undergoing fluctuations which are not only sudden, but extremely severe. An interval of a few seconds often marks the jump from light load to the maximum capacity of the engine, or else a sudden release from full load to no load. Yet, under these trying conditions, the engine is required by the electrical engineer to satisfy in turn and collectively the three important requirements of close regulation, great mechanical endurance and high economy. It is almost needless to say that these three qualities have not yet been reconciled under such conditions. In electric railway practice, it is not uncommon to find a 100 H.P. engine carrying an average load of from 40 to 60 H.P. The fact that the load is likely to jump up now and then to 100 or 120 H.P. makes this margin necessary, for without it, the first two qualities, regulation and endurance, could not be secured. As for the third quality, it is of necessity sacrificed. Even under this compromise the

wheel does in a mechanical way for the engine. It provides the circuit with a kind of reserve fund of energy that is ready to instantly appropriate any surplus of electric power when the load is light, or make up the deficit when it is heavy.

The method consists in connecting to the terminals of, and in parallel with, the ordinary generating dynamo, D, supplying feeder circuit or trolley line, L, a compensating circuit, including a series of storage battery cells, B, B, and the armature, A, of a small supplemental generator. The field magnet coil, M, of this small generator consists of a few turns of large wire similar to the series coil of a compound wound machine. This coil is not included with the armature in the compensating or branch circuit, but is placed in the circuit leading to the trolley line. Consequently, when the circuit switch, S, is thrown to the left, thereby connecting the dynamo to both points, *a* and *b*, and closing both the main and branch circuits, the current sent out to the trolley line, L, will pass through the coils, M, suitable means, such as a shunting rheostat, T, being provided, whereby the effectual ampère turns due to a given current may be adjusted.

The armature, A, of the small machine is driven at constant speed by power obtained from any convenient source, as, for instance, the same engine that drives the main dynamo, D. It might be driven by a separate



durability, as experience shows, is not by any means an assured quality. Practice is indeed drifting to the conclusion that a further compromise must be made to favour still more the second at the expense of the first quality, and engines of slow-speed types are coming into use. This change also favours the third quality incidentally, but only to a remote degree.

The question of economy in electric railway working is not altogether one of engine type or capacity for the particular case. The efficiency of an engine running light is zero; that of an engine overloaded and taking steam during the entire stroke is also very low. Between these two extremes there is a point of maximum efficiency, corresponding usually to the nominal rated capacity of the engine. If the engine can be worked at this capacity, and if fluctuations much above or below this load can be avoided, the conditions will no longer be incompatible with, but will become favourable to, efficiency. With a steadier, more uniform load, the problem of speed regulation of course vanishes, while that of durability becomes greatly simplified.

It was this reasoning which led the writer, some time ago, to devise a method of equalising the engine-load by electrical means, and of rendering the engine independent, to a great extent, of the fluctuations in power consumption on the trolley lines. The method aims to accomplish electrically for the dynamo what the fly-

engine, or by an electric motor supplied from the trolley circuit. This armature is made of low resistance, and capable of carrying a large current.

The cells, B, B, may be of any form, although the Planté type is preferable on account of its simplicity and its ability to withstand severe rates of charge and discharge without injury. These cells need be but of small capacity or only partially formed, since the storing capacity required of them is very small, as will be seen. The number of cells required will depend on the voltage of the circuit. For a 500-volt circuit, which is the usual standard in electric railway practice, a series of about 225 cells would be required. The facilities for adjustment are such, however, that the number of cells may be varied considerably without detriment. It will be seen from the connections that so long as no current is consumed on the line the armature, A, will have its field demagnetised. It therefore generates practically no E.M.F., and constitutes merely a dead resistance.

By the passage of current to the trolley line the field magnet coil, M, is excited and made to produce a definite amount of field magnetism. It is evident, therefore, that the E.M.F. of the armature, A, will depend altogether on, and will rise or fall directly with, the current consumed on the trolley lines. This E.M.F. is so "poled" as to add itself to that of the cells, B, B. It results that when there is no power consumed on the

\* *Electrical Engineer*, New York.

trolley line the voltage of the cells, B, B, will be so much lower than that of the dynamo, D, that there will be a large "overflow" of charging current into them. As the power consumed on the line, L, is increased, the armature, A, will begin to generate an E.M.F. that will raise the effective voltage of the battery and consequently reduce the charging current, until finally at a certain point it will stop altogether. If the current now rises above this limit, it will raise the effective voltage of the compensating circuit above that of the dynamo. Consequently the battery will now begin to discharge current into the circuit just as if it were another dynamo coupled in parallel with the main dynamo, D. When this point is reached, if the field magnet of the small machine is still much below saturation, the further increase of the current may raise the effective E.M.F. of the compensating circuit considerably higher than that of the dynamo. It might seem, therefore, that the dynamo, D, is likely to be over-balanced and converted into a motor.

There is another important factor that intervenes here, however, viz., the polarisation of the battery. It is well known, as one of the disadvantages of storage batteries, that their potential difference is diminished as the discharge current is increased, partly owing to their internal resistance and partly to the effect of polarisation, the latter being especially marked with heavy discharges. It follows from this that the effective voltage of the compensating circuit when the discharge begins, will not rise in proportion to the E.M.F. added by the armature, A, but at a rate which is slower the greater the current; consequently, when a certain current value is reached the rise in effective voltage will be much slower. If this does not suffice to limit the rise of E.M.F. made in the compensating circuit, the adjustments can be made to lower the saturation point of the field cores, so that the bend of the characteristic may correspond to a lower current. This can be done by suitably proportioning the iron in the field magnet cores; or, with a given machine, by varying the effective ampere-turns, by means of the shunting rheostat, T, the speed being changed so as to preserve the same total range of supplemental E.M.F. Thus it is seen that the rise of effective E.M.F. in the compensating circuit can be limited at any desired point.

If the limit is the same as the E.M.F. of the main dynamo, then the compensating circuit will supply about half the current required for the trolley line. If the limit is a trifle higher the compensating circuit will supply slightly more than half. If the limit be sufficiently high the compensating circuit will assume practically the whole load, and relieve the dynamo and engine.

It is not necessary, as might appear at first, that the field cores of the supplemental generator should be laminated, to make the apparatus sensitive and responsive to sudden fluctuations. Advantage, again, is taken here of the polarisation of the batteries. It requires a minute interval of time for a storage battery to polarise or depolarise. This interval will practically balance the time required for the rise or fall of magnetisation.

As a case illustrating the operation of the above method, let us take a dynamo of, say, 50,000 watts capacity, supplying a railway circuit at 500 volts pressure. Under present practice the average load put on such a machine would scarcely exceed 60 amperes, and the engine would be of about 100 H.P. capacity, if not more. Instead of this, an engine of about 80 H.P. would be used, and the average load would be made at least 90 amperes. The compensating circuit would then be so adjusted that whenever the current consumed on the trolley line would fall much below 90 amperes the main dynamo would overflow into the battery. If the consumption ceased altogether, for a brief instant, as so often occurs, the dynamo and engine, instead of running empty, would run at nearly the same output, the whole current being sent into the batteries.

As the current increased on the trolley line the overflow would diminish, and, at a little below 90 amperes, it would cease. Any increase above 90 amperes would cause the battery to discharge and help the dynamo.

The greater and the more urgent the demand for assistance the more promptly and liberally will the supply be given. Not only will the supply provide for the excess of current required above the 90 amperes furnished by the dynamo, but, as shown above, it may be made to relieve the dynamo itself either partly or wholly.

Let us now analyse the action of the compensating circuit. When there is no current on the trolley circuit the current sent into the batteries will pass through the armature, A, as if it were a dead resistance. When current is consumed on the line, however, the magnetic field becomes excited, and the charging current now operates the armature, A, as a motor. The amount of energy thus re-converted is not large, however, since the charging current is large only when the counter E.M.F., generated by armature A, is small, and *vice versa*. When the working current rises above the adjusted limit of 90 amperes the batteries begin to discharge, and the armature, A, then becomes a dynamo.

Let us assume that the load jumps up suddenly to double its average value, or 180 amperes, and remains so for five minutes. Such severe fluctuations are not infrequent, although they scarcely persist, as a rule, longer than from a few seconds to a minute. Let us assume that the compensating circuit will carry the excess of 90 amperes, making, at, say, 501 volts, an output of 45,090 watts. If we assume that the battery will so polarise at this rate of discharge that it cannot be counted upon for more than, say, 1.8 volts per cell, we have, as the available potential difference of the battery,  $225 \times 1.8 = 405$  volts. The armature of the supplemental generator will therefore need to supply  $501 - 405 = 96$  volts. The amount of energy which the supplemental dynamo must provide will consequently be  $96 \times 90 = 8,640$  watts. The battery supplies the rest, or  $405 \times 90 = 36,450$  watts.

If the same engine drives both dynamos, we see that a rise of 100 per cent. in the current load will only cause a rise of 20 per cent. in the output of the engine. The battery furnishes the other 80 per cent. If, however, we consider that the engine is likely to slacken its speed slightly when the fluctuation occurs, or if we adjust the supplemental dynamo to a slightly higher limit of E.M.F. the main dynamo, D, will be partly relieved of its own load.

In other words, the conditions can be made such that the main dynamo will carry, let us say, only 80 amperes, and the compensating circuit 100 amperes. The combined load of both dynamos will now be  $80 \times 500 = 40,000$ , and  $100 \times 96 = 9,600$ ; total,  $40,000 + 9,600 = 49,600$  watts, or only 4,600 watts, or 10 per cent. more than the average working rate of the main dynamo. The battery will supply  $100 \times 405 = 40,500$  watts or 90 per cent. of the energy required in excess of the average load.

The storage capacity required to compass such a severe and prolonged fluctuation is naturally a question of importance. A current of 100 amperes for five minutes represents a total of 500 ampere minutes, or  $\frac{500}{60} = 8.33$  ampere hours. Hence, if each cell has a

storing capacity of only 10 ampere hours, it will have margin sufficient for all contingencies. Even if doubled, the capacity per cell would still be only about one-eighth to one-tenth of the capacity of the cells used in storage battery traction. For a 50,000 watt dynamo the series of cells required would be equivalent in storage capacity to about one-fourth of the battery usually put into each storage battery car.

With the above method of equalising the load, the part assigned to the engine becomes wonderfully easy and simple. The engine no longer is required to anticipate and provide for jumps in the load. It no longer has the responsibility of keeping the current pressure steady, or its supply adequate. Its load becomes so nearly uniform, that the first of the three requirements noted in the beginning, close regulation, is no longer of primary, but is of remote importance, while the second and third are at the same time greatly facilitated.

The slow speed, double valve engine, whose superior economy is conceded, now becomes not only permissible, but eminently practicable. We must also bear in mind that this method further favours economy by materially increasing the working capacity of a given plant, obviating, as it does, the necessity for the margin required under the old way, to compass the fluctuations of load. The method is, it is evident, applicable to all systems of the constant potential description, and is adaptable to circuits fed either direct or by feeders. The method can be applied to any existing plant without difficulty.

On following the connections in the diagram it will be seen that by turning the switch, S, to the right, instead of to the left, the compensating circuit is entirely disconnected, and the plant operates in the usual way, leaving the engine to bear the brunt of any fluctuations in the power consumed. The method admits of being modified and applied in an indefinite variety of ways, which cannot be detailed in this space.

In conclusion, it may be noted that accumulators have been for several years used as equalisers or regulators in connection with incandescent lighting circuits. The compensating action thus obtained, however, is much limited in scope and degree. The battery, when unaided, evidently cannot begin to assist the dynamo until the latter has actually wavered perceptibly in potential; and anything like a severe rate of discharge would at once lower the potential below that of the dynamo itself. Hence, even though, in such cases, large cells are used, to reduce the internal resistance and polarisation to a minimum, the compensating action is useful only for compassing relatively minute and brief fluctuations. By supplementing the E.M.F. of the accumulators, as is done in the method of the writer, the action is rendered independent of the size of battery used or of the extent and degree of the fluctuations to be compassed. Not only this, but the action does not depend on the loss of E.M.F. of the main dynamo. In fact, as we have seen, the method has for one of its objects to obviate any fall of voltage at the dynamo terminals, while it will easily, if desired, produce the contrary effect, or raise the voltage as the load increases, the same as is done by an "over-compounded" dynamo.

## SOME FACTS CONCERNING GUTTA-PERCHA.

(Continued from page 737.)

THE investigations of the four official explorers—Seligmann, Wray, Burck, and Sérullas—agreed in the conclusion that if any of the more valuable varieties of the gutta-percha tree were to be perpetuated, cultivation must be immediately undertaken. These gentlemen differ, however, as to the name of the tree which ought to be propagated.

The *mayang taban dourrian*, of Singgaloungan, in Sumatra, was chosen by M. Seligman.

The *gutta taban mérah*, and the *gueutta taban soutra*, from Perak, in the peninsula of Malacca, were selected by Mr. Wray.

The *niatouh balam Tembaga*, from Ampaloo, Halaban, was considered the best by M. Burck.

M. Sérullas, owing to his having re-discovered the *Isonandra percha* or *Isonandra gutta*, of Hooker, in Singapore, naturally inclined to the propagation of this, the most valuable of all gutta-percha trees. No other *isonandra* (*palaquium* or *dichopsis*, the name matters little), combines the advantages possessed by this variety, whose gum has shown beyond all question or doubt the quality of stability. At the same time, it should be pointed out that other trees of the same species, found in various portions of Malaysia, and known under local names, such as those above-referred to, possess qualities not much inferior to those of the *isonandra gutta*.

In considering the regions natural to the gutta-percha

tree, M. Sérullas indicates Malaysia as the only district, owing to its climatic conditions, where the best varieties are to be met with. This question is one of great importance, for upon it depends the cultivation of this plant in districts to which it is not indigenous.

M. Seligman adopts as the limits of the home of the gutta-percha tree the fifth parallel on each side of the equator. M. Sérullas, however, disagrees with this opinion, and suggests that the isothermal lines at six degrees north and south of the intersection in Malaysia of the geographical and thermal equators confine the zone of the guttas.

If the thermal equator be followed from east to west, starting from the Celebes, it will be found to traverse the island of Borneo, the south of the Malay peninsular, the north of Sumatra, Southern India, the Gulf of Oman, crosses Africa from the Red Sea to the Gulf of Guinea, strikes South America at the Guianas, and crosses it through Venezuela and Colombia to the Bay of Panamá; in the Pacific it leans southward to nearly the Salomon Islands, and after skirting the north coast of New Guinea returns again to Celebes. Along this track, and beyond the limits of its Eastern abode, the gutta-percha trees are represented by the *payena* in Southern India, the *bassia Parkii* in Africa, and the *Mimusops balata* in Guiana, Venezuela, and Colombia.

M. Sérullas indicates various of the French possessions in the East as being suitable for the cultivation of the *isonandra*, and going further afield states that the islands of Réunion and Maurice, in the Indian Ocean, are well adapted for its propagation. Indeed, the gardens in the island of Maurice possess plants of the *Isonandra gutta*, of Wight, which have flourished in a remarkable degree.

It is worthy of mention that in the Island of Celebes, a region to all appearance admirably adapted to the growth of the *isonandra*, not a single variety is found of any value. This is accounted for by the fact that the flora and fauna are Australasian, not Malaysian. But, adds the author, it is beyond doubt that the *isonandra* could be easily acclimatised there. M. Sérullas treats at some length the various terms employed by the Malays in describing different gutta-percha trees. We will select a few of the words more commonly used:—

*Gutta*; *guétah* (Sunda); *gota* (Batak); *gueutta* (Malacca); *gatta* (Macassar); *guitta* (Dyak). Signifies something sticky, like gum or bird lime.

*Pertcha*, *pertjah*, *perdja*, or *peurtcha*. Means rag or strip of cloth, and describes appearance of those gums which, previous to treatment in hot water, look like rags half reduced to a pasty semblance and hard pressed.

*Balam*; signifies a plant giving a milky sap; *Mayang*, the way certain flowers grow; *Kayou*, a certain wood.

*Taban* or *Teban*, though not really the same words, are used to describe a tree of good appearance, one worth cutting down, and are employed to describe a gum of first quality. *Tchaier* signifies liquid, and is applied to gums which coagulate slowly, and are therefore of little value for telegraphic purposes.

*Boucou* or *becou*, knot, lump, or ring, and is descriptive of those gums which coagulate quickly, forming a sort of excrescence at the incision made in the bark.

The two best varieties of gum are distinguished by a difference in colour, one called *mérah* (red) and the other white, known as *soutra* (soft or silky), so as to separate it from another white (*pouteh*) variety, but which is not good enough to be classed as *becou*, and is better than the *tchaier*.

The leaves also have their various descriptive terms. *Tembaga*, coppery, from the colour of the underside; *Tumba*, lance, from the shape; *Dourrian*, from the resemblance to the leaf of the fruit tree of that name. These are all indicative of good quality.

From M. Sérullas's statements, it would appear that a certain gum may be described as a sticky substance coming from a plant which gives a milky sap, produced by a tree of first quality, which flowers in a particular manner, the underside of whose leaves is coppery.

coloured, and whose gum, of a red colour, hardens quickly, or otherwise. Add to these definitions the innumerable names invented by the natives to satisfy the insistence of travellers who desire more precise information, and the difficulty of accurately discriminating between the varieties of percha, can be understood.

The method adopted by the natives of collecting the gums is far more disastrous to the good varieties of trees than to those of inferior quality. In the case of the latter, the sap coagulates but slowly, and an incision made in the bark allows a flow of some hours; a sufficient quantity can be thus collected without having resource to the felling of the trees. With the best kinds it is otherwise; the sap hardens almost immediately, and the incision is speedily closed, allowing but an infinitesimal amount of gum to exude. The plan pursued with these trees is as follows: A scaffolding is raised close to the tree about to be cut down, so as to support it in an inclined position when felled. This having been done, all the branches are lopped off except the lower portions of the larger ones. Incisions are then made completely round the trunk, commencing at the higher part, each about three-quarters of an inch broad, and at about 18 inches apart. It is evident that an enormous waste of gum takes place, for the bark remains untouched between the incisions. From the younger branches of a specimen *M. Sérullas* saw cut down, he obtained fifteen times greater a quantity of gum than collected by the natives from the trunk and large branches, and from the leaves at least twenty-two times that amount.

After the gum has been collected, it is immersed in hot water, kneaded several times, and finally taken out of the water at the end of five or six minutes. It is then spread in very thin transparent sheets. The mixture of other gums, of bark, wood, and stones, takes place subsequently, when the gum is reboiled for this purpose, which is effected in the proportions necessary in the particular case.

A popular error with regard to the Dyak collectors of gutta-percha is the superstition imputed to them of looking upon the period of full moon as the only proper time for collecting. As a matter of fact, says *M. Sérullas*, the period considered by them as the best is immediately after the rains, when the sap runs more freely. A curious circumstance connected with the *locale* of gutta-percha trees, and the observation of which frequently assisted *M. Sérullas* in his search for them, is the fact that where they grow no leeches are to be found, though the immediate vicinity, and the forest in every other direction, may actually swarm with them.

We will not follow *M. Sérullas* in his strictures upon the erroneous information as to the varieties of gutta-percha, the methods of collecting, the yield of sap, &c., published by various travellers, among whom *Oxley*, *Lingard*, *O'Rorke*, and *Collins* are mentioned as principal offenders. The matter is of a certain interest, but occupies too much space. Briefly stated, it would appear that limited observation, imperfect acquaintance with the locality, and a too ready acceptance of native statements, together with the confounding of the methods used in the collection and preparation of india-rubber with those adopted in the case of gutta-percha, may account for many of these errors.

Nor have we space in which to transcribe the author's remarks upon the conditions governing the *Isonandra* in a natural state, or on the question of transporting young plants to a distance from their native forests.

In *La Lumière Electrique*, of December 13th, these matters will be found fully set forth. We may, however, quote, as more particularly interesting, certain observations. It appears that the stumps of gutta-percha trees, after the trunks have been cut down, invariably show a speedy and vigorous growth of buds and shoots. This of course only applies to forests untouched by fire. On several occasions, *M. Sérullas* had the opportunity of observing the wonderfully rapid and healthy growth of cuttings under purely accidental circumstances. In one of these cases the cutting happened to be the trunk of a tree thrown across a stream, and

forming portion of a bridge. As to the transport of young plants, the operation does not seem to have been so very difficult—warmth, shade, and moisture, their principal requirements in their native forests, appear, together with a sufficient protection of the roots, to be the chief essentials.

(To be continued.)

### THE NEW ELECTRIC "MOOTER,"

AS DESCRIBED BY BIDDY M'CLURE IN AN OHM-LY EPISTLE TO  
"A FRIND IN THE OULD COUNTRY."

(An electric motor has just been set up in a Brooklyn hotel for washing dishes.—*Daily Paper*.)

FORNINST the recait av this bit av a letther  
Fram your dear furrin frind, lone Biddy M'Clure,  
I'll just mintion me cowl an' me pay is aich betther  
Since I wint for me misthress, an' thin for the door;  
Shure meself cudn't stay wid her, she had such a way  
wid her—

Och! the month I was there was the tarrible jant!  
So, musha! I sacked her, an' wid me characther  
Crassed over the wather to Brookline beyant.

Good luck to her timper! no less to the bottle,  
By raison av which the same fell on my pate!  
For by the same token, I'm now in a hotel,  
Wid the misthress loike honey, her tongue is that  
swate,

Och! it's here the work's aisy, acushla! the lazy  
Colleens, shure they throubled the misthress a dale,  
Till nothin' wud suit her but to sind for a *mooter*  
For clanin' the dishes up affther aich male.

To describe it, acushla, 's beyand me—the sorra.  
The loike in ould Oireland iver was sane!

Av yez putt a windmill in a washtub, begorra  
There's a thrue-spakin' fortygraph av the machane!  
Arrah! what wid the splashin' av wather an' smashin'  
Av chinie that iligant mooter did make,  
I wint undher the table, entoirely unable  
To do half av me work for the howl av a wake!

Av ye ax *what compels it*, shure a saycret that same is  
As meself ud be proud wid me own frinds to share;  
But it isn't convaynient to spake what the name is  
Wid the spaich av the counthry so furrin an' quare.  
Shure, ye'll know quoite enough whin I say that the  
shstuff

Comes up through a hole in the tap av the flure,  
An' av it's wance shpilt, tare an' ages! it's kilt  
Entoirely thin is poor Biddy M'Clure!

But by this an' by that! it's meself won't decaive ye—  
I'm aloive, an' its marrit I'll soon be to Pat:  
Och, a mooter, alanna, 's a foine thing to lave ye  
Convaynient to do a bit coortin' an' that!  
For while wid the clanin' the mooter was strainin  
Up shteps a foine paler wid helmet an' shtick;  
Says he, "Och, ye craythur! yez two lips is swater  
Than suggar!" says he—"let me tashte thim, avick!"

Thin forninst your recait av this bit av a goster,  
Av the mooter plays thricks, shure your Biddy'll be  
dead;

But av it behaves, an' me Pat's no imposther,  
Thin praise to the Vargin! meself will be wed.  
Wid Pat at the windie, an' this divil's own shindie,  
Och, whirra! I'm ready to drop on the flure!  
So whether I'm baried, or dacently married,  
It's the mooter as done for poor Biddy M'Clure.

*Ariel.*

**Electric Light in Liverpool.**—A petition has been signed by occupiers of a certain district in Liverpool, requesting the Watch Committee to grant to the Liverpool Supply Company the necessary authority to enable them to lay electric lighting mains.

## TELEGRAPH COMPETITION IN THE WEST INDIES.

THE West India Islands, once the scene of a thriving commerce, the resort of an energetic and wealthy community, have, during years of adversity, gradually sunk to a position not far removed from that lowest of all conditions—a negro's paradise. Fallen from their high estate, they are to-day chiefly associated with such petty transactions as the production of swizzle-sticks and guava jelly. The decadence which has overtaken this erstwhile prosperous region—we speak more particularly of the British possessions—and the hopeless stagnation into which affairs have drifted, combine to isolate these islands from busier communities, and fully justify the application of the words “the world forgetting by the world forgot.”

All branches of industry seem to be pervaded with the lethargy resulting from years of inactivity, and the necessarily consequent indifference to progress and improvement has had such a widespread influence, that its effects have been evident in the paralysed condition of even telegraphic enterprise. We do not refer to the management, so far as efficient service and suitable tariffs are concerned, of that association which for nearly twenty years has held undisputed sway, but rather to the weakness and inactivity it has shown in allowing its opportunities to be irretrievably lost, and to the prolonged indifference in the conduct of its affairs, and the utter absence of prevision which have invited opposition schemes.

For a great change in the situation has recently taken place. This typical sleepy hollow, and its Rip van Winkle have been awakened to the fact that a French syndicate has discovered what others failed to appreciate, that the West Indies still offer a field to telegraph enterprise quite worth the cultivating.

This association, the *Société Générale des Téléphones*, founded in 1881, with a capital of 25,000,000 francs, was the prime mover in the establishment of the new submarine telegraph communications in the West Indies; and it is the chief factor in the organisation of the two companies, the *Cie Télégraphique des Antilles* and the *Société Française des Télégraphes Sousmarins*, whose names are more directly associated with the new cables. The first mentioned of these two companies was formed in 1884, with a capital of 200,000 francs, subsequently increased to 450,000; the second was founded in 1888, with a capital of 5,500,000 francs, afterwards increased to 11,000,000 francs.

In reviewing the work completed, in progress and contemplated, of these companies, we may neglect the *Compagnie Télégraphique des Antilles*, on account of the insignificance of its property. Before entering, however, upon a discussion of the aims and circumstances of the *Société Française des Télégraphes Sousmarins*, it will be necessary to revert, for a moment, to the *Société Générale des Téléphones*.

For many years the French Government has sought, whenever possible, to foster the manufacture of submarine cables in France, and to encourage French companies in submarine telegraph enterprise. The telephone company had become the proprietor of the well-known works of Rattier, at Bezons, near Paris; but the inland situation of this factory made it ill adapted for the manufacture and shipping of any considerable lengths of cable. With the view of meeting the wishes of the Government, and considering the probability that the telegraph companies, its *protégés*, would, in the course of time, largely extend their systems, the telephone company cast about for some seaport on the French coast suitable for the erection of a cable manufactory, and affording the necessary accommodation for cable ships. After the examination of several localities, Calais was finally determined on, and the factory at that place, immediately commenced, is now rapidly approaching completion.

An examination into the conditions attending the present development of telegraphic communications in the West Indies would appear incomplete without some

reference to the concessions obtained by the *Société Française des Télégraphes Sousmarins*. The older ones, relating to cables already laid between Cuba, Haiti, Santo Domingo, Curaçao, and Venezuela, need not be recapitulated: we shall therefore confine ourselves to the more recent concessions:—

**Martinique—Guadeloupe (laid).**—Concession dated 7th June, 1889. For 25 years. Exclusive rights to land and work submarine cables. Annual subsidy granted by each island of £2,000.

Note (1). The agreement between the French Government and the West India and Panama Telegraph Company with regard to Martinique, expired on the 31st December, 1889; that relating to Guadeloupe terminates on 1st January, 1895. (2) The new concession stipulates that these islands shall be connected with some point on the present system. This in all probability will be either Santo Domingo or Puerto Plata, in the Republic of Santo Domingo. The payment of the subsidies must naturally mainly depend upon the establishment of this connection, by means of which the southern portion of the system is brought in communication with Cuba.

**Guadeloupe — Marie Galante (laid).** — Concession dated January, 1890. For 25 years. Annual subsidy granted of £400.

**Cayenne (French Guiana).** (To be laid shortly).—Concession dated 11th October, 1889. For 25 years. Exclusive rights of traffic. Annual subsidy granted of £4,000.

Note.—The concession stipulates that Cayenne shall be connected directly or indirectly with either Martinique or Guadeloupe.

**Paramaribo (Dutch Guiana).** (Laid 1890.) Concession dated 18th September, 1889. For 20 years. Exclusive rights for landing and working cables between Surinam and Cayenne, Venezuela, Curaçao, Haiti, Santo Domingo, Cuba, Martinique, Guadeloupe, and New York. Annual subsidy granted by Dutch colony of £2,400.

**Brazil — United States.** — Concession dated 10th January, 1890. For 35 years. Exclusive rights for transmitting, by one or more cables, directly or indirectly, all telegrams addressed to the United States which may be handed to the Brazilian Government telegraph stations, and exclusivity for all cable communications between Brazil and the United States.

Note (1). The Brazilian Government undertakes to afford the French Company special facilities for the interchange of traffic. (2) An earlier concession had been granted to the *Pedro Segundo Telegraph Company*, which, in an agreement with the *Société Française*, bound itself to connect this company's system with Brazil, and to obtain landing rights for it in the State of New York. (3) The concession granted to the *Pedro Segundo Company* lapsed owing to non-fulfilment on the part of the company.

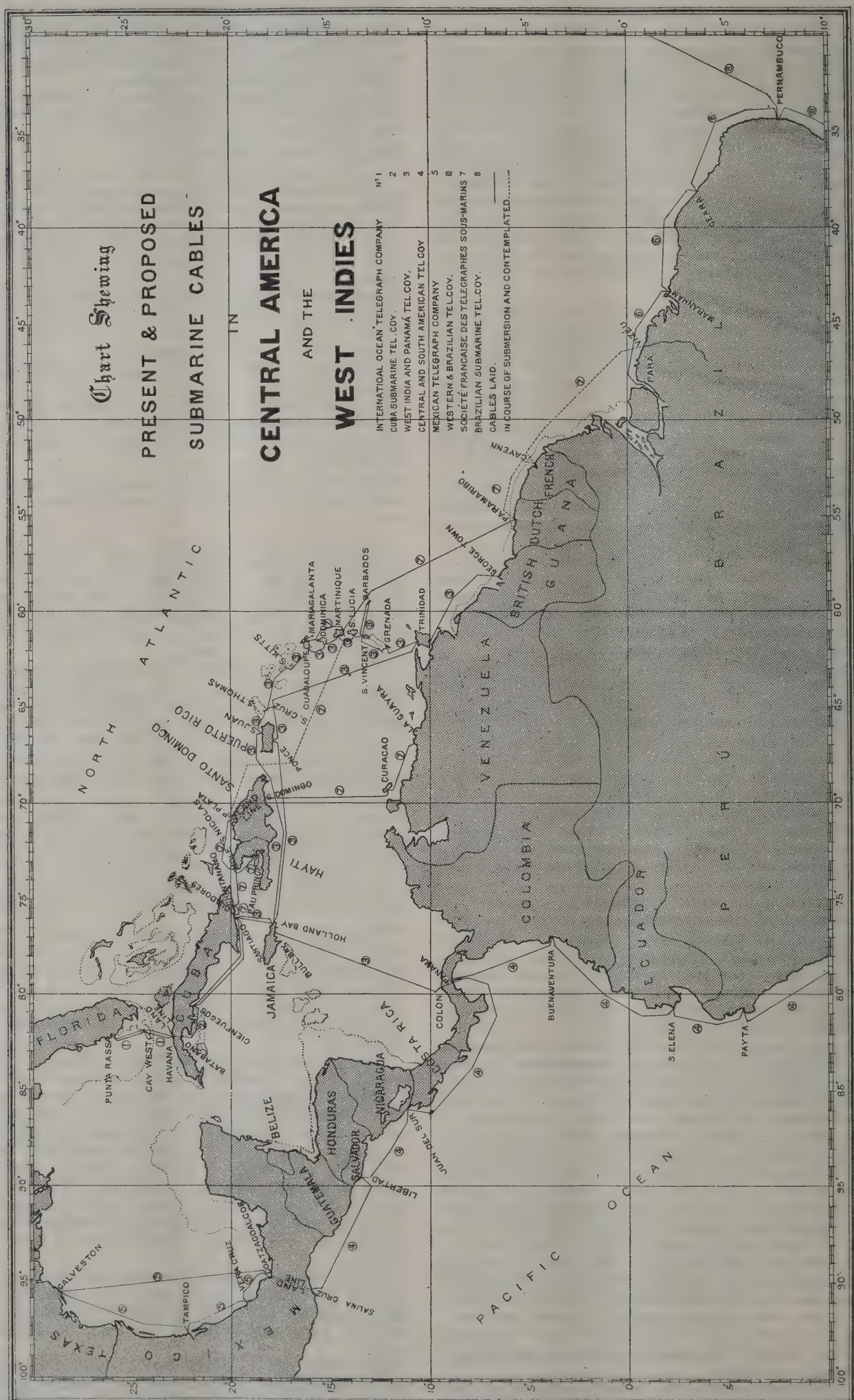
**Vizeu (Brazil)—Cayenne (French Guiana).** (To be shortly laid.) This section is included in the above-mentioned Brazilian concession, which contains a clause to the effect that Vizeu, in the province of Pará, shall be connected to the French Company's system, by means of a submarine cable, on or before the 26th August, 1891.

**Mole St. Nicolas—Port-au-Prince (Haiti).** (To be shortly laid.) Concession dated 28th June, 1888. For 60 years. Exclusive rights for landing and working cables. Purchase of cable, by Haitian Government, by instalments extending over 2½ years, for £24,000.

**Haitian Land-lines.**—Concession dated 14th April, 1890. For 60 years. Exclusive rights in Haiti for constructing and working land-lines. The Government guarantees an annual interest of 8 per cent. on the capital expended in constructing certain lines, on the basis of £68 as cost per kilometre of line constructed.

**North Coast of Cuba.**—Concession granted by the Spanish Government for connecting, by means of submarine cables, the town of Santiago de Cuba with the principal ports on the north coast of the Island of Cuba.

**Santo Domingo.**—The exclusive rights for landing and working cables in the Republic of Santo Domingo expired on the 1st of August, 1890. A prolongation of these rights up to 1st August, 1892, has been obtained



through the Société Générale des Téléphones, by the payment of £12,000.

The foregoing brief sketch, although not altogether complete, sufficiently indicates the position held by the French company; it is still undecided what route will be followed by the cable, or cables, necessary to connect Martinique and Guadeloupe with that portion of the system which gives an outlet from the West Indies *viâ* Cuba. The connection might be made either at La Guayra, at Curaçao, or at the port of Santo Domingo; in each of these instances the land-lines across the island of Santo Domingo would become a part of the main system. Or the cable, as will probably be the case, might be laid direct, from either Martinique or Guadeloupe to Puerto Plata, on the north coast of Santo Domingo, where the existing cables between that port and Cuba afford the desired communication.

The chart which accompanies this article will give a better idea of the situation than could possibly be obtained from a mere verbal description, and one cannot but wonder, on inspecting this chart and reviewing the programme of the French company, how it is that they have been allowed to occupy certain coigns of vantage.

A study of the circumstances would undoubtedly lead one to assume that the proper course for the company, which during nearly 18 years prior to the advent of the new undertakings, had held in its own hands the undisputed possession of the entire telegraphic communications in the West Indies, was to have secured itself in every feasible manner from the possible attacks of rival enterprises. The necessary precautions, however, were neglected, the opportunity was allowed to pass, and the Société Française, by establishing itself in Cuba, Haiti, Santo Domingo, Curaçao, and Venezuela, by ousting the West India and Panama Company from the islands of Martinique and Guadeloupe, by acquiring possession of the communications with the French and Dutch Guianas, and by securing an entry into Brazil, has obtained a permanent footing, not, indeed, without a struggle, in what should have been the elder company's reservation.

The Cuba Submarine and the West India and Panama Companies, awakened too late to the gravity of the situation, vigorously opposed the landing of the French cables on the island of Cuba, and for some time succeeded in hindering the opening of those lines to the public, maintaining that the wording of the concessions granted by the Spanish Government distinctly included exclusive landing rights in Cuba. On the advice, however, of the colonial section of the Council of State in Madrid, a Royal decree was promulgated authorising the French companies to land their cables in Cuba. The decree was dated January 17th, 1889, and the lines between Haiti and Cuba were opened for international traffic on February 7th of the same year. We imagine that the French company has, for this decision in its favour, in a great measure to thank the feeling, which of late years has become very noticeable in Madrid, that the West India and Panama Company has not fulfilled its engagements, nor adhered to the intention of the concession granted it in 1868. It is not our purpose, at least for the present, to discuss the merits of the case, but some mention of the circumstances seems necessary, more particularly as this very cable between Haiti and Santo Domingo is the keystone of the position, so far as the West India and Panama Company and the French Association are concerned.

The French company has secured, either by its own concessions or by alliance with friendly associations, cable communication between Cuba and Brazil; a new route between South America and the United States and Europe has thus been opened, and the stations on this new line will have duplicate communications with the outside world. Although this advantage is great, it is somewhat diminished by the fact that the Société Française depends, at present, for an outlet upon companies which have hitherto not shown themselves very favourably disposed towards the new enterprise.

At the Cuban extremity of the French system, com-

munication with North America and Europe is obtained through the Cuba Submarine Company's cables along the south coast of Cuba, and the International Ocean Company's lines between Havanah, Key West, and Florida: at Vizeu, the Brazilian termination of the system, a route to Europe is opened either *viâ* the Brazilian Government land lines to Pernambuco, or through the Western and Brazilian Company's cables between Pará and Pernambuco, at which latter place the Brazilian Submarine Company's trans-Atlantic cables terminate on the South American coast.

How much importance may be attached to the concessions granted to the French company for the cable along the north coast of Cuba is yet to be seen; under existing conditions such lines could only serve as local feeders to the general system, and the French company may have to push on its connections from its West Indian system, either direct to the United States, or may even be compelled to seek an outlet *viâ* St. Pierre, Miquelon, which place is directly connected to France by a transatlantic cable.

Far more menacing, however, is the position of the Société Française in the extension southwards of its cables. We refer to the circumstances which have permitted this association to continue its lines from the Guianas to Brazil, and it seems a very extraordinary omission that the gap between Demerara and Pará has not long ago been bridged over with some efficient means of communication. It is manifest that such a connection would have been most advantageous to the West India and Panama Company, and some exceedingly strong reasons must exist, other than difficulties in obtaining concessions, for neglecting so important a link. Perhaps the presence on the board of the West India and Panama Company of directors of the Western and Brazilian, and Brazilian Submarine companies, may in some measure, account for what may be described as remarkable apathy. We will not dwell, however, on this more personal portion of the subject, since it does not come within the scope of this article to discuss why, or how, an individual can attempt to serve two masters whose interests appear to be diametrically opposed.

An attempt was made in 1874 to connect Brazil with the West Indies. Cables were laid between the Guianas and Pará by the long defunct Central American Telegraph Company; but as a means of communication these lines were literally ephemeral, lasting but a day. It is to be remarked that the West India and Panama Company, at the time, or shortly after, these cables were laid, entered into negotiations for their purchase, if, indeed, it did not become actually the proprietor of them. It is also worthy of note that the arrangements entered into between the West India and Panama Company on the one hand, and the Brazilian Submarine and Western and Brazilian Companies on the other, seemed to result in the utter collapse of the Central American cables. We are ignorant as to what attempts, if any, may have been made to repair these cables, but this much is certain, they were speedily abandoned.

In considering the results which are likely to attend the establishment of the cables of the French companies, certain important factors must not be lost sight of.

The concessions granted by the Brazilian Government to the Société Française will hinder, for the time being, the organisation of a completely independent cable route between Brazil and the United States. The American Government, as a rule, does not care to sanction the landing of cables on American territory by an association which, from the exclusive rights it might have acquired, could oppose obstacles, in another country, to the landing of cables by any American citizen. It must be remembered that reciprocity is a leading feature in American politics. It is not probable, however, that the French company will, on account of this temporary difficulty, be long debarred from that outlet which is of so vital importance to its interests. Sooner or later it is certain to find means for obtaining the communication necessary to guarantee the efficiency of its system.

Although, as above set forth, the French Company is, for the time being, hampered in its action, a distinct gain to it in another direction fully compensates for that temporary inconvenience. The struggle for the possession of Brazilian and other South American traffic has assumed an acute phase, and energetic measures are being undertaken by rival enterprises on both sides of the South American continent to secure this traffic. The Western and Brazilian Company on the east coast is in strong competition with the Central and South American Company on the west coast; and when the French West India lines are completed to Brazil it is fair to assume that the Western and Brazilian Company will find it to their advantage to work in accord with the new enterprise. It is evident that the French cables offer a more natural route for telegraphic communications between North and South America than the existing one by which this traffic is under the necessity of twice crossing the Atlantic. That the importance of the commercial relations between South America and the United States fully justifies the establishment of the new communications, is shown from the estimated value of South American telegraph business, which may be placed at about £300,000 per annum. It is probable that of the messages represented by this amount a satisfactory proportion will be diverted to the French cables.

*The Submarine Cable Systems of the Compagnie Télégraphique des Antilles and the Société Française des Télégraphes Sousmarins.*

From.	To.	When laid.	Approximate length N.M.
Aguadores, Cuba...	Caimanera, Cuba	1888	50
Caimanera, Cuba...	Môle St. Nicolas, Haiti	1888	126
Môle St. Nicolas, Haiti	Port au Prince, Haiti	To be laid shortly	106
Môle St. Nicolas, Haiti	Puerto Plata, Santo Domingo	1888	188
Puerto Plata, Santo Domingo	San Domingo, Santo Domingo	{ Land-line } 1888	95
San Domingo, Santo Domingo	Santa Ana, Curaçao	1888	453
Santa Ana, Curaçao	La Guayra, Venezuela	1888	163
Puerto Plata, Santo Domingo	Fort de France, Martinique	To be laid shortly	670
Fort de France, Martinique	Pointe à Pitre, Guadeloupe	1889	118
Pointe à Pitre, Guadeloupe	St. Louis, Marie-Galante	1889	25
Fort de France, Martinique	Paramaribo, Dutch Guiana	1890	685
Paramaribo, Dutch Guiana	Cayenne, French Guiana	To be laid shortly	252
Cayenne, French Guiana	Vizeu, Province of Pará, Brazil	To be laid shortly	575

So far as the Brazilian traffic with the United States is concerned, the West India and Panama Company can hope for no share; but it is otherwise as regards the Cuba Submarine and the International Ocean Telegraph Companies. It is beyond question that these associations have everything to gain from friendly alliance with the new enterprise, since their systems would directly benefit by such traffic as might come to them from the French cables; and, further, these amicable relations might secure immunity from the consequences to be expected by the establishment of competing lines. Let these companies take warning from the isolation which the West India and Panama Company has brought upon itself.

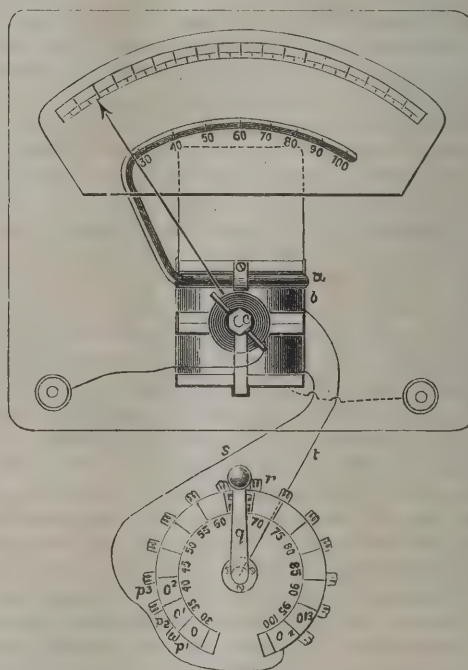
The accompanying table showing the cables of the French companies laid, in progress, and contemplated, may assist to an appreciation of the situation.

### WESTON'S TEMPERATURE REGULATOR FOR MEASURING INSTRUMENTS.

AMONG the errors to which electric measuring instruments are subject is that due to the heating of the coils by the passage of the current. This evidently increases their resistance, and changes the value of the readings indicated. To avoid this as much as possible recourse is had to wire having as low a temperature co-efficient as possible; but such wire of German silver or platinoid is very expensive when the finer sizes are employed, and hence it becomes desirable to retain copper wire if some means can be provided for correcting the error due to the change in resistance resulting from temperature variations.

Realising this disadvantage, says the *Electrical Engineer*, N.Y., Mr. Edward Weston, Newark, N.J., has recently brought out an important addition to his well-known and admirable instruments, consisting of a temperature regulator, but which is, of course, applicable to instruments wound with whatever kind of wire.

In order that variations in temperature may be recognised, Mr. Weston provides a thermometer, *m*, the mercury bulb of which is elongated, and is curved and fastened directly against the exterior of the coil. The thermometer tube is bent, as shown, and arranged upon the scale plate, and in a curve parallel to that of the scale markings. By means of this thermometer the temperature of the coil is shown upon the same scale plate as the regular indications of the instrument.



A series of contacts, *o* to *o*<sup>14</sup>, insulated from one another, are arranged in a circle, and between the successive contact plates are included resistance coils, *p*<sup>1</sup>, *p*<sup>2</sup>, *p*<sup>3</sup>, &c. Pivoted concentrically with the circle of contact plates is a switch-arm, *q*, having contact springs bearing upon the surface of the contact plates, *o*.

This device is interposed in the circuit of the fixed coil, and is connected to it by the wires, *s*, *t*. The contact plates, *o*, *o'*, &c., are marked to correspond to the thermometer scale. Thus the contact plate, *o*, is marked "30" to correspond to the 30° mark of the thermometer, the contact plate, *o'*, corresponds to the 35° mark of the thermometer, and so on, the contact plate, *o*<sup>14</sup>, corresponding to the 100° mark. When the arm, *q*, is placed on the contact plate, *o*, it will be evident that the current in the instrument then passes through all the resistances, *p*, *p*<sup>1</sup>, *p*<sup>2</sup>, and, *p*<sup>3</sup>.

Suppose, for instance, that this is the starting point of temperatures, and that the heat of the coil increases, so that the thermometer shows a temperature of 65°. This means an increase of resistance in the coil due to the 65° difference of temperature. In order to compensate for this the switch arm, *g*, is moved around until its contact spring rests on the plate, *o'*, marked "65." Seven resistances, *p*, *p'*, will thus be thrown out of the circuit, and as each resistance corresponds to the increase of resistance in the coil due to the elevation of 5° of temperature, it follows that by throwing out seven of these resistances we have exactly compensated for the increased resistance of the coil due to its increased heat.

In practical operation, therefore, it is simply necessary to note the indication of the thermometer, and place the arm, *g*, on the contact plate mark corresponding to that indication, in order to keep the resistance of the circuit in the instrument uniform.

## ELECTRIC RAILWAYS.\*

By THEO. P. BAILEY.

THE practical development of electric street railways, and their commercial perfection, may properly be said to have been accomplished within two years, and yet there are at the present time 246 electrical street railway plants either in operation, or ready to be put in operation, within a short time. Two years ago, and even within the past 12 months, we were asked many questions by intending purchasers, which to-day are not even hinted at. Some of the prevailing questions of that age were:—

Can electricity be applied in our case?

Can a street railway, equipped with electricity, be made a practical and commercial success?

What will be the life of the apparatus?

What will it cost to keep the apparatus in repair?

Is not the current dangerous to human life?

Will it not ruin the watches of passengers?

The street railway people to-day appear to have become thoroughly satisfied on these questions, and consider it an idle waste of time to discuss them further. But in lieu they ask us this: "How soon can you furnish the equipment for our road, and what will it cost?" Just think of this statement for a moment: Two hundred and forty-six electrical railways in operation, embracing 2,024 miles of track, and 3,830 motor cars, requiring in the neighbourhood of 6,400 motors with a probable aggregate capacity of 174,435 horse-power, employing an electrical generating capacity at the station of about 94,880 horse-power! Did any one of you anticipate two years ago that such a condition of facts could under any circumstances be realised within so short a time? I attribute this wonderful development and success to the following causes:—

First, the full practicability of the undertaking; second, the wonderful earning capacity of the electrically equipped car as compared with the horse car; third, a determination on the part of the electrical manufacturers to meet the requirements of the railway companies; and fourth, the untiring and undefatigable efforts of the exploiter or salesman.

Among the numerous and possibly fatal objections raised to the use of electricity, when it was proposed to apply it to street car propulsion, was that grades exceeding 5 per cent. could not be mounted. But experience and practice have shown that grades as high as 14 per cent. can be ascended with reasonable safety and satisfaction. There is a grade of 13  $\frac{1}{10}$  per cent. at one point on the line of the street railway at Lynn, Mass., over which 16-foot cars equipped with two 15 horse-power motors are in daily and successful operation. At Milwaukee a grade of 10  $\frac{3}{10}$  per cent., 430 feet long, is encountered and successfully operated over by 20-foot cars, equipped with two 15 horse-power motors, the total weight of car complete with passengers being 10  $\frac{1}{2}$  tons. A similar grade is met with at Newport, R.I., and Omaha, Neb., and numerous grades almost as heavy are seen in the electric railway systems at Des Moines and Davenport, Ia., and Kansas City, Mo.

At the present time there are as nearly as can be ascertained 957 street railways in the United States and Canada. Of this number 589 are operated by horses; 49 by cable; 246 by electricity; 73 by steam.

It is estimated that the total money value of these combined properties is \$164,400,000, proportioned as follows:—Horse railways, \$58,900,000; cable railways, \$49,000,000; electric railways, \$49,200,000; steam railways, \$7,300,000.

These figures are at best only approximations, as it has been found impossible to secure absolutely accurate information.

This combination of motive powers is doing service over or upon 8,818 miles of track as follows:—Horses, 5,713; cable, 527; electric, 2,024; steam, 554.

I find that the cost per car mile for the several methods referred to, including all operating expenses and fixed charges, other than interest, is as follows:—Horses, 5.7 cents; cable, 2  $\frac{1}{2}$  cents; electric, 2.2 cents; steam, 5 cents.

A large majority of the street cars equipped electrically at the present time are mounted upon a single truck, to which are attached one or two motors, as required by the conditions existing in each particular case. The lightest equipment with which I have had to do has been a single 15 horse-power motor upon one truck; and the heaviest equipment has been two 15 horse-power motors upon one truck. The tendency, however, at the present time seems to be in the direction of longer cars, double trucks, and heavier motors. This action is prompted very largely, no doubt, by the sad and costly experience of some companies where trailers were used in connection with the motor car; serious accidents, and in some cases death, having resulted from injuries sustained by passengers in falling between the motor and trail car while passing from one to the other.

The use of the longer car with double trucks is recommended further as a means of comfort to the passengers, and also on account of the longer life of the car and its equipments. This style of car is, of course, unattended by the oscillating motion found in the shorter car with a single truck. Where the shorter motor car is used with a trailer experience shows that there is a great loss in wear and tear by reason of the cars jamming together when the brakes are applied. This fault is obviated in the longer car, and while its seating capacity may not be equal to that of two shorter cars, it is approximately so. It is claimed further for the longer car with double trucks that less energy is required to operate it; also that it saves the expense of one man, decreases the expense of maintenance, and increases the facility for handling passengers.

In treating of the subject of electric railways from a commercial standpoint, I have considered only that branch designated as the single wire overhead system.

For obvious reasons too much care cannot be observed in planning and locating the various factors which go to make up a complete electric railway plant. Assuming that the railway company has secured the desired franchises and rights of way, has laid out its lines of track so as to avoid all excessive grades, and yet reach the attractive and important points of the town or city, and that it has been fortunate enough to make proper selection of its apparatus, the next important work for it to determine is the location and arrangement of its power station. The selection of a site should be made with reference to obtaining the best facility for handling coal and securing water, and also with reference to the electrical centre of the railway system, in order to realise the highest degree of economy in the operation of the plant. The arrangement of the power station is equally as important as its location, with regard to handling the work with the least cost for labour. The selection of the steam plant is a matter of great importance, and should be left with a thoroughly competent and reliable engineer to determine what particular type of engine, boiler, &c., should be used; and the matter should be left under his direction and care until the installation has been completed. It is manifest that in so doing serious blunders will be avoided. I do not think it can be justly claimed that the railway companies have been too liberal in the amount of horse-power purchased for the operation of their generators. In order to secure the best results, with reference to reliability of service, the horse-power of the engine should be at least 20 per cent. greater than that of the generator which it drives, in order to provide for loss in transmission and excessive loads which are thrown on the generator by reason of a large number of cars starting at the same time; or on account of a ground being accidentally thrown upon the line. The steam plant should be so arranged and connected to the generators that either engine or generator may be readily interchanged; and the arrangement of the engines and generators should be made with reference to future extensions. The switch-board containing the indicating and regulating devices, should be located so as to be most accessible to the attendant.

Both the power and electrical plant when complete and ready for operation, should be placed in the hands of men of experience and learning in these departments, in order to ensure reliability of service, and the greatest economy in operation and maintenance. I would rather provide in advance for the expenditure of \$1,000 or more in this department than to run any risk of having to pay out four times that amount in repairs and losses occasioned by mistakes of incompetent men.

The location and arrangement of the car house is a question of considerable importance, and open to serious mistakes growing out of bad location or improper interior arrangement. Some advantages are secured by locating the car house immediately adjacent to the power station. In this case it may be heated with the exhaust steam from the power plant, and the services of employees utilised in both buildings, and repairs to apparatus concentrated at one point. The car house should be provided with suitable pits for the inspection of the motors, and also have proper accommodations for cleaning the car bodies. If the car house is to accommodate more than 20 or 25 cars, it should be provided with running and turning tables, and should also have more than one exit.

I cannot pass from the question of inspection of apparatus without emphasising the extraordinary importance of having this work done thoroughly by competent and faithful attendants. With electrical apparatus of standard makes we can reasonably expect that a motor car sent out in the morning for the work of the day, having passed through proper inspection, will perform its duty with a degree of certainty that need leave but little, if any, cause

\* Read before the Chicago Electric Club, November 17th, 1890.

for anxiety. This feature is, perhaps, the most difficult one to impress upon the management of electrical railway companies, more especially where such railways have been converted from animal power. If railway companies will guarantee that degree of care and watchfulness in the operation of their motors indicated above, we take practically no chances by giving them the broadest guarantees as to the durability of the apparatus, and the cost of maintenance and repair.

It is apparent that in the overhead construction the highest degree of care should be exercised as to its details and arrangement, for this part of the equipment is constantly open to criticism. We cannot blind our eyes to the fact that serious, and, in some instances, fatal criticism has been made to this work. We must all avail ourselves of the experience which has attended our efforts, and see to it that our overhead construction is not in any case, or for any reason, slighted.

I think an iron pole 28 or 30 feet long, made in three sections of extra strong pipe 6 inches in diameter at the base, and 4 inches at the top, provided with wheel base and insulated cap, presents the most slightly appearance on the street, and forms the most substantial construction that can be had. Next in reliability and appearance is an octagonal pole of Southern pine suitably painted; and, lastly, and the pole most commonly used, the Western Union standard. These poles should be properly set with sufficient rake to allow of sustaining a strain of at least 900 lbs. To these poles should be attached by means of eye-bolts a galvanised steel wire having a diameter of at least  $\frac{1}{4}$  of an inch, and drawn taut so that the poles will come to a perpendicular position. To these span wires there should be attached a suitable insulating device over the centre of each track with proper attachments for suspending the trolley wire. This insulating device should be small in its construction, consistent with strength and high insulation, and the insulating material formed in such manner that it will in itself constitute a protection against moisture. The trolley wire should, in my judgment, be at least  $\frac{3}{8}$ ths of an inch in diameter, considering the objection that is raised to the multiplication of wires in the streets. This wire should be hard-drawn copper in lengths of at least one mile each. In this case, the number of splices is reduced to a minimum, and by means of a suitable splicing ear the joints can be neatly, perfectly, and securely made.

Where the streets are of a width of at least 60 feet from curb to curb, it is regarded as thoroughly safe and practicable in cases of double track roads to place the poles in the centre of the street between the tracks, and whether these poles be made of iron or of wood of octagonal shape, I consider that this arrangement presents the best form of overhead construction that can be secured.

When a conduit can be constructed that will permit of the safe, reliable and economical operation of street railways by means of electricity, we will all rejoice, and be glad. If its first cost can be made sufficiently reasonable to permit its use in cities of, say 50,000 inhabitants, it will be a magnificent achievement, and one that will surely bring its just reward to the successful inventor.

This thought is not prompted by reason of any vexatious troubles or annoyances which have occurred in the operation of the overhead system, but wholly on account of the objections which have been raised to the rapid multiplication of poles and wires in the streets, occasioned by the remarkable development and progress of the electrical science.

One of the prominent electrical companies is, and has been for some time, carrying on extensive and elaborate experiments with conduits, but have not, I believe, fully satisfied themselves of the commercial success of their latest undertaking.

I find little or no objection to overhead wires in place of less than 50,000 inhabitants. For this reason, and the fact of its low first cost, the overhead system will no doubt continue to be used in such places for some time to come, regardless of developments in the conduit system.

One of the most important features of an electric railway system is the track or road bed. My experience has been that sufficient attention has not been given to that part of the equipment, especially until very recently. The track should be constructed of a good form of girder or "T" rail, weighing 54 lbs. or 40 lbs. per yard respectively, and should be attached securely to suitable ties placed not more than  $2\frac{1}{2}$  feet apart. It should be well ballasted, and where crossings are made over other tracks solid castings should be used in order to prevent the jolting and jarring which occurs when passing over them. The rails should be kept as clean as possible where they are used as a part of the return circuit. In order to use the rails of the track in completing the return circuit they should be firmly connected together by a copper wire in addition to the ordinary fish plates, and in certain cases, depending wholly upon the length of the line, number and extent of grades, and number of cars and amount of traffic, there should be used a supplementary copper wire, the size of which must depend upon the conditions just named. It is asserted by some electricians that the efficiency of the return circuit is increased in all cases by the use of a supplementary wire; but my experience has been upon small roads where the grades and traffic are light, that satisfactory and economical operation is secured where the supplementary wire is omitted.

Some of the essential requisites of an electric motor car are proper controlling mechanism and reversing switch for controlling the speed and direction of the car, a lightning arrester and multiple fuse box. It should also be provided with suitable life guards, bells, and head lights. The wheels of the car should in my judgment be at least 33 inches in diameter and weigh 300 lbs. each.

This will give increased adhesion and allow the motors to be raised sufficiently high from the ground to prevent practically the possibility of its being injured by striking obstacles between the rails.

Increased speed with a very slight increase of power will result by the use of the 33-inch instead of the 30-inch wheel.

The possible speed of a car equipped electrically is measured only by the limit of safety. The regulation speed in the majority of places is twelve miles per hour, and the average mileage per car per day about 115. It is well known that upon well regulated steam railroads the locomotives rarely make a continuous run of over 100 miles per day; and considering the extraordinary care that is given to them, and remembering in the same connection the very slight degree of care given to the average electric street railway motor, I think the latter is entitled to a very handsome compliment for the good service it gives us; and when you know that the best average mileage that can be made by a car propelled by the Kentucky horse or Texas mule is 60 miles per day, and even in doing this it is necessary to make at least four changes per day, I think you will admit that the electric railway motor is doing most admirable service.

The smallest town in the United States which has an electric street railway in operation is Southington, Conn., with a population of 5,400. Two cars are in service over two miles of track, and the average daily receipts are \$9.00 per car. The power for the operation of this road is furnished by the local lighting company, and costs \$1.25 per car per day. The largest electric railway is at Boston, Mass. The entire system comprises 284 miles of track, sixty of which are electrically equipped, and there are 312 motor cars in operation. During the month of August they had 300 motor cars in service, making a total mileage of 384,700,000. The mileage of the tow cars 59,948,000; making a total car mileage of 444,648,000. From August 10th to August 16th, 700,000 passengers were carried by these cars without a single delay. In the month of September, 312 motor cars were in operation, making a mileage of 343,466,000, and the mileage of tow cars 56,047,000, making a total car mileage of 399,513,000. The following is a statement of one road:—

Average number of motor cars run per day...	20
Average number of trail cars run per day ...	0
Average number of hours per car in service per day ...	18
Average number of miles per car per day ...	108
Electromotive force ...	500
Average ampère readings taken hourly ...	122
Average electrical horse-power ...	81.8
Average electrical horse-power per car ...	4.9
Number of passengers carried per day ...	11,060
Number of passengers carried per car per day ...	553
Cost of operating per car mile ...	\$ 0616
Receipts per car mile ...	2560
Cost of operating per car per day ...	6 65
Receipts per car per day ...	27.65

Most flattering testimonials have been received from railway companies who have adopted the electric system, and while they express their absolute satisfaction with the new motive power they also state, that the earning capacity of their road has been materially increased. In some cases the increase is given as high as 400 per cent., and in others as low as 50 per cent., but in no case that I can now remember has the increase been given lower than the amount last stated.

Inquiry is sometimes made as to whether a motor car can be safely and reliably operated without a conductor. The present form of trolley and overhead construction readily permits of this; but I do not regard it as practicable or advisable except in the smaller places where the business of the road will not justify the expense of a conductor. I am familiar, however, with a number of roads in towns or cities having a population of less than 30,000 where the car is in the exclusive charge of the motorman, and no trouble is experienced in its operation. With a good track there is little, if any, possibility of accident when proper care is exercised in taking curves and switches. Where the business will warrant the expense, however, there should be a conductor with every car or train.

We cannot overlook the fact that there are still some complaints of excessive cost for repairs and maintenance of the electrical apparatus, but I insist that the responsibility for this condition does not rest altogether with its manufacturers. The managers of these electric roads must appreciate that they are exacting a greater mileage duty of their motors than is expected of the ordinary railroad steam engine and under conditions manifestly more unfavourable. If they will admit this, and see to it that their tracks are put in good order and so maintained, and the same degree of care and attention given to their motors that is given to the steam engine, I am satisfied they will have little to complain of. How rarely do you find an electric motor operated on a track like that prepared for the steam engine? And how seldom do you find a man in charge of the motor car who has the intelligence, training and experience of the steam engineer?

Several railway companies which adopted the cable system before the possibilities of the electric system were fully appreciated or understood, are now seriously considering the complete displacement of that system and the substitution of electricity in its stead. I was recently informed by the president of one of the electric railway companies, whose line is a competitor to a cable road, that the latter company, feeling keenly the effect of the

competition of the electric system had about concluded to reduce the fare on their road to 4 cents per passenger. Before this action takes place, however, I have no doubt that some bright representative of the electric system will persuade our cable friend to join the procession of progress, abandon the cable, welcome and adopt electricity as the motive power, and thus preserve the independence and stability of his street railway system.

There is no system or method of rapid street transportation that is so universally popular as the electric system; its wonderful flexibility is unparalleled in the history of street railways; capable of moving in either direction with equal facility, its value is materially enhanced from the standpoint of safety. Its first cost is about the same as for the animal system, and considerably less than the cable system. Knowing what the possibilities of the electric system are, and how cheaply it can be maintained and operated under proper conditions, I think we will see street railways thus equipped in many towns of a population not exceeding 10,000, and in some cases even less, and at a period not very remote.

I have previously alluded to the remarkable growth of the electric railway business, and given some reasons for it, but I do not feel that full justice has been done to the pioneers—I mean the manufacturers of the apparatus. When you consider what they had to do, and what they did do, in order to inspire confidence in the undertaking, I think you will all agree with me that they have merited even greater success than has attended their efforts, if that be possible. Contracts with all sorts of guarantees were made, long trial periods were given, the cost of maintenance guaranteed to be less than for the same number of cars operated by animal power, the current guaranteed not to be fatal to human life, and the system warranted to work in a thoroughly practical and successful manner, with a general and sweeping provision that in case of failure in any of the guarantees, the railway company could, at their option, throw the apparatus out, and assess the electrical company any damages which they had sustained by reason of the alleged experiment. Was there ever a new industry vouched for so absolutely by its projectors? Had the electric companies been less liberal with their guarantees, and not exhibited such a marked degree of confidence themselves, we undoubtedly would have been able to-day to count the number of electric railways by tens instead of by hundreds, for it is but a short time since the financial world has given its unqualified indorsement to the system. Bankers and trust companies took no part in formulating public sentiment or confidence in this matter. The undivided burden was assumed and borne by the electrical company, and not until they had fulfilled their numerous guarantees faithfully and well, and demonstrated beyond all peradventure the full and complete success of the electric street railway was the moneyed man or corporation willing to assume any hazard or risk. How the conditions have changed in two short years! Every principal city in the United States now has its electric street railway; full confidence has been established, and unreasonable guarantees are no longer required.

In closing, permit me to offer this prediction, that within a few years, surface and elevated railways operated by animal, cable, or steam power, will be numbered with the events of the past, and electricity, with all its beautiful attributes, in all its grandeur and magnificence, and in the full measure of the wide range of its possibility, will claim supremacy in the broad realm of street railway transportation.

## THE ELECTRO-MAGNET.\*

By Prof. SILVANUS P. THOMPSON, D.Sc., B.A., M.I.E.E.

(Continued from page 747.)

### EFFECT OF USING CONED PLUNGERS.

But now if, instead of employing a cylindrical core, you employ one that is pointed, you find this completely alters the position of the maximum pull, for now the point is insufficient to carry the whole of the magnetic lines which are formed in the iron rod. They do not come out at the point, but filter through, so to speak, along the sides of the core. The region where the magnetic lines come up through the iron into the air is no longer a definite "pole" at or near the end of the rod, but is distributed over a considerable surface; consequently when the point begins to poke its nose out, you still have a larger portion of iron up the tube, and the pull, instead of coming to a maximum at that position, is distributed over a wider range. I am now making the experiment roughly with my spring balance and a conical plunger, and I think you will be able to notice a marked difference between this case and that of the cylindrical plunger. The pull increases as the plunger enters, but the maximum is not so well defined with a pointed core as it is with one that is flat-ended. This essential difference between coned plungers and cylindrical ones was discovered by an engineer of the name of Krizik, who applied his discovery in the mechanism of the Pilsen arc lamps. Coned plungers were also examined by Bruger. In fig. 63 are given the

curves that correspond to the use of a coned iron core, as well as those corresponding to the use of the cylindrical iron rod. You will notice that, as compared with the cylindrical plunger, the coned core never gave so big a pull, and the maximum occurred not as the tip emerged, but when it got a very considerable way out on the other side. So it is with both the shorter and the longer coil. The dotted curves in fig. 64 represent the behaviour of a coned plunger. With the longer coil represented, and with various currents, the maximum pull occurred when the tip had come a considerable way out; and the position of the maximum pull, instead of being brought nearer to the entering end, with a high magnetising current, was actually caused to occur further down; the range of action became extended with large currents as compared with small ones. Bruger also investigated the case of cores of very irregular shapes, resembling, for example, the shank of a screw-driver, and found a very curious and irregular force-curve. There is a good deal more yet to be done, I fancy, in examining this question of distributing the pull on an attracted core by altering the shape of it; but Bruger has shown us the way, and we ought not to find very much difficulty in following him.

### OTHER MODES OF EXTENDING RANGE OF ACTION.

Another way of altering the distribution of the pull is to alter the distribution of the wire on the coil. Instead of having a coned core use a coned coil, the winding being heaped up thicker at one end than at the other. Such a coil, wound in steps of increasing thickness, has been used for some years by Gaiiffe, in his arc lamp; it has also been patented in Germany by Leupold. M. Trève has made the suggestion to employ an iron wire coil, so to utilise the magnetism of the iron that is carrying the current. Trève declares that such coils possess, for an equal current, four times the pulling power. I doubt whether that is so; but even if it were, we must remember that to drive any given current through an iron wire, instead of a copper wire of the same bulk, implies that we must force the current through six times the resistance; and, therefore, we shall have to employ six times the horse-power to drive the same current through the iron wire coil, so that there is really no gain. Again, a suggestion has been made to enclose in an iron jacket the coil employed in this way. Iron-clad solenoids have been employed from time to time. But they do not increase the range of action. What they do is to tend to prevent the falling off of the internal pull at the region within the mouth of the coil. It equalises the internal pull at the expense of all external action. An iron-clad solenoid has practically no attraction at all on anything outside of it, not even on an iron core placed at a distance of half a diameter of the aperture; it is only when the core is inside the tube that the attraction begins; and the magnetising power is practically uniform from end to end. Last year I wished to make use of this property for some experiments on the action of magnetism on light, and for that purpose I had built, by Messrs. Paterson and Cooper, this powerful coil, which is provided with a tubular iron jacket outside, and a thick iron disc perforated by a central hole covering each end. The magnetic circuit around the exterior of the coil is practically completed with soft iron. With this coil, one may take it, there is an absolutely uniform magnetic field from one end of the tube to the other; not falling off at the ends, as it would do if the magnetic circuit had simply an air return. The whole of the ampère-turns of exciting power are employed in magnetising the central space, in which, therefore, the actions are very powerful and uniform. The coil and its uses were described in my lecture last year at the Royal Institution on "Optical Torque."

### MODIFICATIONS OF THE COIL AND PLUNGER.

In one variety of the coil and plunger mechanism, a second coil is wound on the plunger. Hjörth used this modification, and the same thing has been employed in several arc lamps. There is a series of drawings upon this wall, depicting the mechanism of about a dozen different forms of arc lamp, all made by Messrs. Paterson and Cooper. In one of these there is a plunger, with a coil on it, drawn into a tubular coil, the current flowing successively through both coils. In another there are two separate coils in separate circuits, one of thin wire and one of thick, one being connected in series with the arc, and one in shunt.

### DIFFERENTIAL COIL AND PLUNGER.

There is a third drawing here showing the arrangement, which was originally introduced by Siemens, wherein a plunger is drawn at one end into the coil that is in the main circuit, and at the other end into a coil that is in shunt. That differential arrangement has certain peculiar properties of which I must not now stop to speak in detail. It is obvious that where one core plunges its opposite ends into two coils, the magnetisation will depend on both coils, and the resultant pull will not be simply the difference between the pull of the two coils acting each separately. There is, however, another differential arrangement, used in the Brockie-Pell and other arc lamps, in which there are two separate plungers attached to the two ends of a see-saw lever. In this case the two magnetising actions are separate. In a third differential arrangement there is but one plunger and one tubular bobbin, upon which are wound the two coils, differentially, so that the action on the plunger is simply due to the difference between the ampère-turns circulating in the two separate wires.

\* Cantor Lecture. Delivered before the Society of Arts, February 3rd, 1890.

## COIL AND PLUNGER COIL.

When one abandons iron altogether, and merely uses two tubular coils, one of wide diameter, and another of narrower diameter, capable of entering into the former, and passes electric currents through both of them, if the currents are circulating in the same fashion through both of them they will be drawing into one another. This arrangement has also been used in arc lamps. The parallel currents attract one another inversely, not as the square of the distance, but approximately as the distance. This is one of those little details about which it is as well to be clear. About once a year some kind friend from a distance writes to me pointing out a little slip that he says occurs in my book on electricity, in the passage where I am speaking about the attraction of parallel wires. I have made the terrible blunder of leaving out the word square; for I say the attraction varies inversely as the distance, and my readers are kind enough to correct me. Now when I wrote that passage I considered carefully what I had to write, and the attraction does not vary inversely as the square of the distance, because two parallel wires do not act on one another as two points. They act as two straight lines or two parallel lines, and the attraction between two parallel lines of current, or two parallel lines of magnetism, or two parallel lines of anything else that can attract, will not act inversely as the square, but simply inversely as the distance is between.

## INTERMEDIATE FORMS.

Now this property of the coil and plunger of extending the range of action has been adopted in various ways by inventors whose object was to try and make electro-magnets with a sort of intermediate range. For certain purposes it is desirable to construct an electro-magnet which, while having the powerful pull of the electro-magnet, should have over its limited range of action a more equable pull, resembling in this respect the equalising of range of the coil and plunger. Some of these intermediate forms of apparatus are shown in the following diagrams. Here (fig. 65)



FIG. 65.—PLUNGER ELECTRO-MAGNET OF STEVENS AND HARDY.

is a peculiar form of electro-magnet; it combines some of the features of the iron-clad electro-magnet with those of the movable plunger; it has a limited range of action, but is of great power over that range, owing to its excellent magnetic circuit. It was invented in 1870, by Stevens and Hardy, for use in an electric motor for running sewing machines. A very similar form is used in Weston's arc lamp. A form of plunger electro-magnet, invented by Holroyd Smith in 1877, resembles fig. 65 inverted, the coil being surrounded by an iron jacket, whilst a plunger, furnished at the top with an iron disc, descends down the central tube to meet the iron at the bottom.

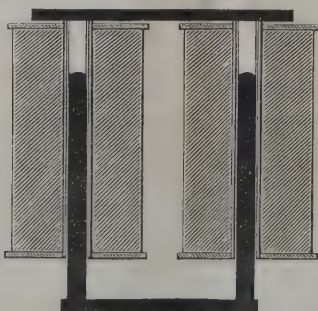


FIG. 66.—ELECTRO-MAGNET OF BRUSH ARC LAMP.

Then there is another variety, of which I was able to show an example last week by the kindness of the Brush Company, namely, the plunger electro-magnet employed in the Brush arc lamps. A couple of tubular coils receive each an iron plunger, connected

together by a yoke; whilst above, the magnetic circuit is partially completed by the sheet of iron which forms part of the enclosing box. You have here, also, the advantage of a fairly complete magnetic circuit, together with a comparatively long travel of the plunger and coil. It is a fair compromise between the two ways of working. The pull is not, however, in any of these forms, equal all along the whole range of travel; it increases as the magnetic circuit becomes more complete.

There are several other intermediate forms. For example, one inventor, Gaiser, employs a horseshoe electro-magnet, the cores of which protrude a good distance beyond the coils, and for an armature he employs a piece of sheet iron, bent round so as to make at its ends two tubes, which enclose the poles, and are drawn down over them. Contrast with this design one of much earlier date by an engineer, Roloff, who made his electro-magnets with iron cores not standing out, but sunk below the level of the ends of the coils, whilst the armature was furnished with little extensions that passed down into these projecting tubular ends of the coils. Some arc lamps have magnets of precisely that form, with a short plunger entering a tubular coil, and met half-way down by a short fixed core inside the tube.

Here (fig. 67) is one form of tubular ironclad electro-magnet that deserves a little more attention, being the one used by Messrs. Ayrton and Perry in 1882; a coil has an iron jacket round it, and also an annular iron disc across the top, and an annular iron disc across the bottom, there being also a short internal tube of iron extending a little way down from the top, almost meeting another

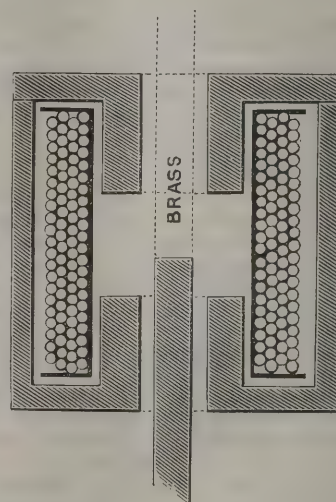


FIG. 67.

AYRTON AND PERRY'S TUBULAR IRONCLAD ELECTRO-MAGNET.

short internal tube of iron coming up from the bottom. The magnetic effect of the enclosed copper coil is concentrated within an extremely short space, between the ends of the internal tubes, where there is a wonderfully strong uniform field. The range of action you can alter just as you please in the construction by shortening or lengthening the internal tubes. An iron rod inserted below is drawn with great power and equality of pull over the range from one end to the other of these internal tubes.

## ACTION OF MAGNETIC FIELD ON SMALL IRON SPHERE.

In dealing with the action of tubular coils upon iron cores, I showed how, when a very short core is placed in a uniform magnetic field, it is not drawn in either direction. The most extreme case is where a small sphere of soft iron is employed. Such a sphere, if placed in even the most powerful magnetic field, does not tend to move in any direction if the field is truly uniform. If the field is not uniform, then the iron sphere always tends to move from the place where the field is weak to a place where the field is stronger. A ball of bismuth, or one of copper, tends, on the contrary, to move from a place where the field is strong to a place where the field is weaker. This is the explanation of the actions called "dia-magnetic," which were at one time erroneously attributed to a supposed diamagnetic polarity opposite in kind to the ordinary magnetic polarity. A simple way of stating the facts is to say that a small sphere of iron tends to move up the slope of a magnetic field, with a force proportional to that slope; whilst (in air) a sphere of bismuth or one of copper tends, with a feeble force, to move down that slope. Any small piece of soft iron—a short cylinder, for example—shows the same kind of behaviour as a small sphere. In some of Ayrton and Perry's coiled-ribbon ampère-meters and voltmeters, and in some of Sir William Thomson's current meters, this principle is applied.

## SECTIONED COILS, WITH PLUNGER.

An important suggestion was made by Page, about 1850, when he designed a form of coil and plunger having a travel of indefinitely long range. The coiled tube, instead of consisting merely of one coil, excited simultaneously throughout its whole length by the current, was constructed in a number of separate sections or short tubes, associated together end to end, and furnished with means for turning on the electric current into any

of the sections separately. Suppose an iron core to be just entering into any section, the current is turned on in that section, and as the end of the core passes through it, the current is then turned on in the section next ahead. In this way an attraction may be kept up along a tube of indefinite length. Page constructed an electric motor on this plan, which was later revived by Du Moncel, and again by Marcel Deprez in his electric "hammer."

#### WINDING OF TUBULAR COILS AND ELECTRO-MAGNETS.

The mention of this mode of winding in sections leads me to say a few final words about winding in general. All ordinary coils, whether tubular or provided with fixed cores, are wound in layers of alternate right-handed and left-handed spirals. In a preceding lecture I mentioned the mistaken notion, now disproved, that there is any gain in making all the spirals right-handed or all left-handed. For one particular case there is an advantage in winding a coil in sections; that is to say, in placing partitions or *cloisons* at intervals along the bobbin, and winding the wire so as to fill up each of the successive spaces between the partitions before passing on from one space to the next. The case in which this construction is advantageous is the unusual case of coils that are to be used with currents supplied at very high potentials. For when currents are supplied at very high potentials there is a very great tension\* exerted on the insulating material, tending to pierce it with a spark. By winding a coil in *cloisons*, however, there is never so great a difference of potentials between the windings on two adjacent layers as there would be if the layers were wound from end to end of the whole length of coil. Consequently, there is never so great a tension on the insulating material between the layers, and a coil so wound is less likely to be injured by the occurrence of a spark.

Another variety of winding has been suggested, namely, to employ in the coils a wire of graduated thickness. It has been shown by Sir William Thomson to be advantageous in the construction of the coils of galvanometers to use for the inner coils of small diameter a thin wire; then, as the diameter of the windings increase, a thicker wire; the thickest wire being used on the outermost layers; the gauge being thus proportioned to the diameter of the windings. But it by no means follows that the plan of using *graded wire*, which is satisfactory for galvanometer coils, is necessarily good for electro-magnets. In designing electro-magnets it is necessary to consider the means of getting rid of heat; and it is obvious that the outer layers are those which are in the most favourable position for getting rid of this heat. Experience shows that the under layers of coils of electro-magnets always attain a higher temperature than those at the surface. If, therefore, the inner layers were to be wound with finer wire, offering higher resistance, and generating more heat than the outer layers, this tendency to over-heating would be still more accentuated. Indeed, it would seem wise rather to reverse the galvanometer plan, and wind electro-magnets with wires that are stouter on the inner layers and finer on the outer layers.

Yet another mode of winding is to employ several wires united in parallel, a separate wire being used for each layer, their anterior extremities being all soldered together at one end of the coil, and their posterior extremities being all soldered together at the other. Magnetically, this mode of winding presents not the slightest advantage over winding with a single stout wire of equivalent section. But it has lately been discovered that this mode of winding with *multiple wire* possesses one incidental advantage, namely, that its use diminishes the tendency to sparking which occurs at break of circuit.

#### EXTENSION OF RANGE BY OBLIQUE APPROACH.

I now pass to the means which have been suggested for extending the range of motion, or of modifying its amount at different parts of the range, so as to equalise the very unequable pull. There are several such devices, some electrical, others purely mechanical, others electro-mechanical. First, there is an electrical method. André proposed that as soon as the armature begun to move nearer, and comes to the place where it is attracted more strongly, it is automatically to make a contact, which will shunt off part of the current and make the magnetism less powerful. Burnett proposed another means; a number of separate electro-magnets acting on one armature, but as the latter approached these electro-magnets were one after the other cut out of the circuit. I need not say the advantages of that method are very hypothetical. Then there is another method which has been used many times with very great success, the method of allowing the motion of the armature to occur obliquely, it being mechanically constrained so as to move past, instead of towards the pole. When the armature is pulled thus obliquely, the pull will be distributed over a definite wider range. Here is a little motor made on that very plan. A number of pieces of iron set on the periphery of a wheel are successively attracted up sideways. An automatic device breaks the circuit as every piece of iron comes near, just at the moment when it gets over the poles, and the current being cut off, it flies on beyond and another piece comes up, is also attracted in the same way, and then allowed to pass. A large number of toy

motors have been made from time to time on this plan. I believe Wheatstone was the first to devise the method of oblique approach about the year 1841. He made many little electro-magnetic motors, the armatures of which were in some cases solid rims of iron arranged as a sort of wheel, with two or more zig-zag internal teeth, offering oblique surfaces to the attraction of an electro-magnet. Such little motors are often now used for spinning Geissler's vacuum tubes. In these motors the iron rim is fixed, and the electro-magnet rotates. The pole of the electro-magnet finds itself a certain distance away from the iron ring, it tries to get nearer. The only way it can get nearer is by swinging round, and so it gradually approaches, and as it approaches the place where it is nearest to the internal projection of the rim the current is cut off, and it swings further. This mode may be likened to a cam in a mechanical movement. It is, in fact, nothing else than an *electro-magnetic cam*. There are other devices, too, which are more like *electro-magnetic linkages*. If you curve the poles or shape them out you may obtain actions which are like that of a wedge on an inclined plane. There is an electro-magnet in one of

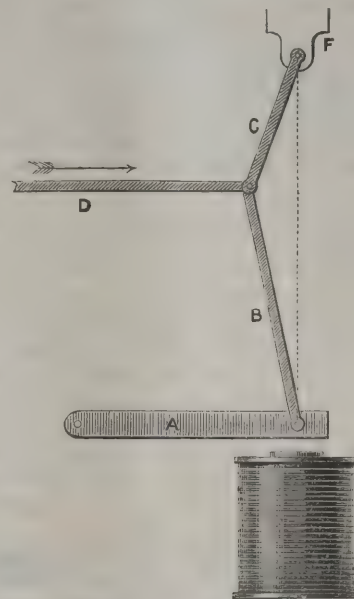


FIG. 68.—FROMENT'S EQUALISER WITH STANHOPE LEVER.

Paterson and Cooper's arc lamps wherein the pole-piece, coming out below the magnet, has a very peculiar shape, and the armature is so pivoted with respect to the magnet, that as the armature approaches the core as a whole, its surface recedes from that of the pole-piece, the effect being that the pull is equalised over a considerable range of motion. There is a somewhat similar device in De Puydt's pattern of arc lamp.

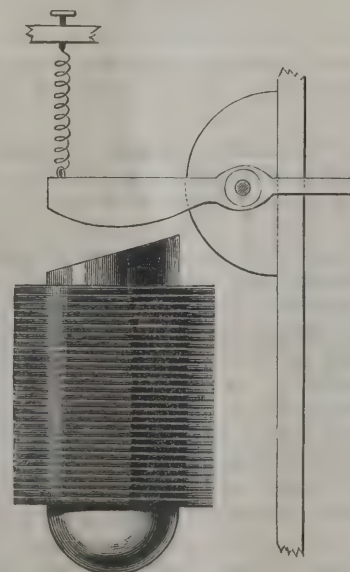


FIG. 69.

DAVY'S MODE OF CONTROLLING ARMATURE BY SPRING.

Here is another device for oblique approach, made by Froment. In the gap in the circuit of the magnet a sort of iron wedge is put in, which is not attracted squarely to either face, but comes in laterally between guides. Another of Froment's equalisers, or distributors, consists of a parallel motion attachment for the armature, so that oblique approach may take place, without actual

\* The tension on the insulating material, tending to pierce it with a spark, is proportional to the square of the difference of potentials (per unit thickness) to which the insulating material is subject. It is incorrect to talk about the tension of the conductor, or about the tension of the current; for the tension or electric stress is always an action affecting the di-electric or insulating material.

contact. Here, fig. 68, is another mechanical method of equalising devised by Froment, and used by Le Roux. You know the Stanhope lever, the object of which is to transform a weak force along a considerable range into a powerful force of short range. Here we use it backwards. The armature itself, which is attracted with a powerful force of short range, is attached to the lower end of the Stanhope lever, and the arm attached to the knee of the lever will deliver a distributed force over quite a different range. One way, not of equalising the actual motion over the range, but of counterbalancing the variable attractive force, is to employ a spring instead of gravity to control the armature. So far back as 1838, Edward Davy, in one of his telegraphic patents, described the use of a spring (fig. 69,) to hold back the armature. Davy preceded Morse in the use of a spring to pull back the armature. There is a way of making a spring act against an armature more stiffly as the pull gets greater. In this method there is a spring with various set screws set up against it, and which come into action at different ranges, so as to alter the stiffness of the spring, making it virtually stiffer as the armature approaches the poles. Yet another method is to employ, as the famous conjuror, Robert Houdin, did, a rocking lever. Fig. 70 depicts one of Robert Houdin's equalisers. The pull of the electro-magnet on the armature acts on a curved lever, which works against a second one; the point of application of force between the one and the other altering with their position. When the armature is far away from the pole, the leverage of the first lever on the second lever is great. When the armature gets near, the leverage of the first lever on the second is comparatively small. This employment of

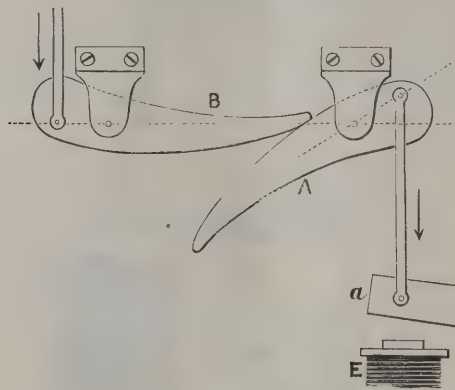


FIG. 70.—ROBERT HOUDIN'S EQUALISER.

the rocking lever was adopted from Houdin by Duboscq, and put into the Duboscq arc lamp, where the regulating mechanism at the bottom of the lamp contains a rocking lever.

(To be continued.)

## REVIEW.

*A Treatise on Electro-Metallurgy.* By WALTER G. McMILLAN, F.I.C., F.C.S. Charles Griffin & Co., London.

The aim of the author of this excellent treatise has been to explain the principles of his subject while avoiding "the accumulation of a mass of unnecessary detail." The work is divided into 18 chapters with addenda consisting of various useful tables.

In the first chapter, the scope of the subject is set down as including electrotyping, electroplating, extraction of metals from their ores, and the dissolving of the surfaces of metals. This is followed by an interesting historical sketch of the few isolated facts known to the ancients, and in the middle ages, up to the date of the discovery of the voltaic battery, which, together with the researches of Faraday and others, is then shown to have led to the remarkable development of the art in the present century. As is the case with so many other important inventions, electrotyping appears to have been simultaneously discovered by several different investigators; Jacobi, of St. Petersburg, and Spencer and Jordan in England.

The second chapter contains the physical and chemical knowledge necessary for understanding the subsequent chapters of the treatise, and though on the whole clear and to the point, we regret to say we have found more blemishes here than in any other part of the work. The author defines matter as that which

possesses *weight*; purely *mass* is the essential property of matter; weight is merely a force acting on matter, analogous to electric or magnetic attraction. Also no clear distinction is drawn between force and energy, of which latter, force forms only one factor; at page 22, "chemical force is converted into and rendered evident as heat energy;" and "it is no more possible to create force or energy, &c." A little further down on the same page we read: "We are rarely able to convert the whole of one kind of energy into any other;" the author should have said—*never*. The definition of a watt at p. 37 requires elucidation and amendment. "A current of 1 ampère at the pressure of 1 volt is termed a watt; it is a most useful unit for comparing different currents, and is really the product of volume into pressure;" the product of volume into pressure does not involve the element of time, whereas the *watt* does.

In Chapter III. we have excellent descriptions of batteries, dynamos, and other generators, suitable for electroplating; in some cases a little more detail, we think, might have been given. The author then proceeds to the more technical part of his subject, and here the subject matter is well chosen, and admirably arranged to suit the requirements either of a novice or of a practical electro-metallurgist. Chapter IV. contains general conditions to be observed in electroplating. Chapter V. relates to plating adjuncts and disposition of plant; and Chapter VI. to the cleansing and preparation of work for the depositing vat, and subsequent polishing of plated goods. In Chapter IV. we note a valuable table, showing the average current values suitable for depositing certain metals.

Chapters VII. to XIV. treat of the deposition of various metals and alloys. In each case valuable tables are given of the composition of the baths, giving also the authorities for their use, their special application, and other useful information. At p. 141, an interesting account is given of the experiments of Von Hübl on the effect of varying current strengths on the nature of the copper deposit; and at p. 147, the effect of the burnishing employed in the Elmore process on the tensile strength of the copper. The remaining chapters are devoted to metal extracting and refining processes, electrolytic quantitative analysis, and some other useful matters.

With the exception of the few blemishes which we have noticed above, and which may well be remedied in a second edition, we can commend Mr. McMillan's treatise as one of the best and most complete manuals hitherto published on electro-metallurgy.

## NOTES.

**Swansea and the Electric Light.**—At the last meeting of the electric lighting committee of the Swansea Corporation several reports were presented, amongst them being one from the borough surveyor, and another from Mr. W. H. Preece. The latter gentleman stated that the tender which complied with existing conditions was that of Messrs. Crompton and Company. The system was free from danger, and provided a continuous supply of electric energy of great constancy and steadiness. Speaking of street lighting, he stated that arc lamps, when placed not too far apart, and when they burned with steadiness, invariably gave satisfaction. Glow lamps, unless of considerable power, rarely did so. For street lighting, anything less than 32 C.P. was objectionable, and 50 C.P. was far preferable. The committee decided to accept the tender of Messrs. Crompton to erect twenty-three arc lamps of 2,000 C.P., at a cost of £25 each per annum, the increased charge for which over gas would be £171 per annum.

**Electricity and the Census.**—Austria is about to follow the example of America, and will use an electrical counter at the next taking of the census.

**Electric Lighting of Brussels.**—A Belgian daily newspaper states that the municipality of Brussels has definitely resolved not to grant a concession to any company for the electric lighting of that town, but to reserve to itself the right of exploiting the lighting. Thus the propositions which have been made to the municipality on the subject will not be carried into effect. This decision is said to have been arrived at owing to the conditions under which the town could buy up the station, &c., at the termination of the 25 years' concession, being too onerous.

**Lighting of Vienna.**—The Second Section of the Vienna Municipality has approved of the project between the latter and the International Compressed Air and Electricity Company. According to the scheme, the latter company is empowered to break up the streets to lay down cables and air-pipes, and the concession is given for 45 years. The Municipality can, however, on giving three years' notice, purchase the undertaking at the end of 15, 25, or 35 years.

**Electric Lighting at Bournemouth.**—At a meeting of the Bournemouth Town Council, last week, a letter was read from the Board of Trade forwarding the report and balance sheet of the Brush Electrical Engineering Company, who are carrying out an extensive installation in the favourite Hampshire watering place. The Town Clerk was instructed to reply that the accounts furnished appeared to show that the company was in a position to discharge the duties imposed by the order. Permission was also given the company to erect certain temporary overhead wires.

**The Brighton Council and the Brighton and Hove Electric Lighting Company.**—At a meeting of the Brighton Council last week, the General Purposes Committee reported the receipt of notice from the above company of an intended application to the Board of Trade for a Provisional Order, pursuant to the Electric Lighting Acts 1882 and 1888, and that they had instructed the Town Clerk to oppose on behalf of the Corporation, and authorised him to retain Parliamentary agents, counsel, and witnesses for that purpose.

**Electric Light in Post Office Work.**—It is said that the authorities contemplate installing the electric light in the Bristol general post office. The sorters and other officials, who are obliged to work long hours, complain of the considerable discomfort caused by the heat of the numerous gas jets in the various departments.

**Electric Light in Scarborough.**—The local authority has decided to apply for a provisional order.

**Progress of Civilisation.**—The King of the Sandwich Islands, who is at present in New York, is endeavouring to get a telegraphic cable laid between San Francisco and Honolulu.

**The Electric Light and Ventilation.**—The *Journal of Gas Lighting*, in a lengthy article on "Gas and Electric Lighting and Ventilation," thus concludes:—"There is no need for talking vaguely on this subject; and, in order to bring the question to an issue, we will take a familiar example—the hall of the Society of Arts. This hall is supposed to be ventilated in the so-called 'natural,' as distinguished from the 'mechanical' method, by a sun-light exit shaft, and fresh air admission behind the dado. The sun-light is now replaced by pendants of electric lamps. The question is whether it is better or worse with electric lighting than when gas was solely used. We believe it is much worse; but this is a point the Society ought, in justice to itself, to set right by competent inquiry. Until this is done, and the reputation of the electric lighting is cleared, we shall continue to hold, on *prima facie* evidence, that the Society's hall is now one of the worst ventilated public rooms in all London, thanks to its electric lamps. And what is true of this hall is probably true, in degree, of many others."

**The Pacific Cable.**—We reproduce the following paragraph from the Melbourne *Herald* of November 6th:—"Once more Canada has renewed her offer to subsidise liberally any company which shall lay a submarine telegraphic cable between her Pacific coast and Australia. The advantages which would accrue to us from the construction of the line have been again and again described in the *Herald*. It would be quite out of the way of the volcanic disturbances which have so frequently broken our communications by the Eastern route. It would be very easily protected against enemies at sea, and would pass through none but British territory on shore. It would open up communications between Canada and Australia which could not fail to extend our trade, and it would give us a cheaper tariff than we at present pay. It is evident that these are all objects highly important to us. The existing lines pass through territory which may at any moment become hostile, and they are open not only to breakage by submarine eruptions but also to be fished up and broken by an enemy's vessels. In the event of a war we might neutralise the North Pacific line by inducing the United States to take over the guardianship of the cable; but no such course would be open to us with regard to the existing lines, which are quite beyond our control. Ships would presently follow the cable, and a large trade could soon be done with British Columbia. The run from Australia to Vancouver is a quick one, and a quiet one. Our seasons are the direct opposite of those of Canada, and we could sell our wines, our fruits, and many products there, which she requires, just as in return she could help us with many commodities. Assuredly, the entire subject deserves the immediate notice of the Government, who can have no grander task set them than that of drawing together the two great dependencies which between them make up Greater Britain."

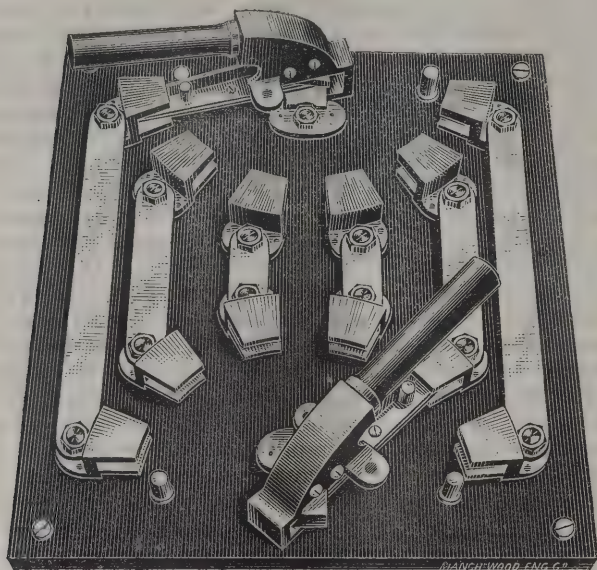
**Royal Naval Exhibition.**—The electric lighting committee, the members of which are Sir Wm. Thomson, Capt. Eardley Wilmot, R.N., Mr. E. H. Carbutt, Mr. W. H. Preece, and Mr. J. I. Thornycroft, have decided to entrust the lighting of the entire exhibition to Messrs. Siemens Bros. & Co., who will furnish the dynamos and lamps. The engines will be supplied by Messrs. Willans and Robinson, and the boilers for the electric light, as well as for the machinery in motion, will be from the well-known works of Messrs. Davey, Paxman and Co. At this initial stage, it is premature to say exactly what the extent of the lighting will be; but it is the intention of the committee to make the lighting a brilliant affair in all respects. Some 200 arc lamps and 2,000 glow lamps will probably be required to illuminate the buildings and grounds, and the dynamos will also have to supply current for several interesting applications of the transmission of power, and for the lighthouse of Messrs. Chance Bros., which will form one of the features of the exhibition.

**Handy Lists of Technical Literature.**—We have received from M. H. E. Haferkorn, of Fourth Avenue, Milwaukee, Wis., Part II.A of his publication, "Handy Lists of Technical Literature." This portion is devoted to books on electricity and magnetism, telegraph, gas, &c., and the compiler believes that this is the first attempt to catalogue the literature on electricity of the period 1880 to October, 1890, in a practical and time-saving way. Everybody interested in this steadily growing branch of study would readily appreciate Mr. Haferkorn's "handy list" as a guide in searching for books on special subjects.

**The Henley Companies.**—Meetings of Henley's Telegraph Works, Limited, and Henley's Electric Light and Power Company, Limited, were held yesterday at the offices, 27, Martin's Lane, E.C. Press representatives were refused admission.

**Electric Light in a Carpet Factory.**—The well-known carpet factory of Messrs. Henderson & Co., of Durham, has been fitted with the electric light.

**Regulator for Accumulator.**—The engraving shows Messrs. Dorman and Smith's patent regulator for use on accumulator circuits. The change in the number of cells being charged or discharged is obtained in such a



manner that the cells are never short-circuited, and the step-by-step motion is instantaneous, even when the handle is moved slowly, this result being obtained in a simple manner, without triggers or complications.

**Mechanics' Almanac.**—A useful workshop companion is Calvert's Mechanics' Almanac, 1891, being the eighteenth year of its publication. It contains a large amount of information specially interesting to artisans and handicraftsmen, illustrated with diagrams.

**A Committee on Electrical Standards.**—The President of the Board of Trade has appointed a committee consisting of the following gentlemen, viz. :—

Lord Rayleigh, F.R.S.	{	Representing the Royal Society.
Sir William Thomson, F.R.S.		
Prof. G. Carey Foster, F.R.S.	{	Representing the British Association for the Advancement of Science.
R. T. Glazebrook, Esq., F.R.S.		
Dr. John Hopkinson, F.R.S.	{	Representing the Institution of Electrical Engineers.
Prof. W. E. Ayrton, F.R.S.		
E. Graves, Esq.	{	Representing the General Post Office.
W. H. Preece, Esq., F.R.S.		
Courtenay Boyle, Esq., C.B.	{	Representing the Board of Trade.
Major P. Cardew, R.E.		

to consider whether any and, if so, what steps should be taken for the provision of electrical standards. The first meeting of the committee will be held at the Board of Trade on Thursday, the 15th of January. Sir Thomas Blomefield, of the Board of Trade, will act as Secretary to the committee.

**New York Subways.**—We extract the following paragraph from a letter which reached us this morning from the States :—"In spite of all the public outcry in New York City, the subways are very little used. The companies interested in electric leads give as an excuse the extravagant rent charged for use of the subways; the latter are owned or controlled by the "Western Union" and "Bell Telephone," so it is easy for them to have the rent for use fixed to suit themselves.

**Share List.**—Pressure on our space prevents us publishing the usual share list this week; but we observe the following changes from last Thursday's prices :—Consolidated Telephones were quoted at from  $\frac{1}{2}$  to  $\frac{5}{8}$ , Elmore's Coppers have gone up and stand at from  $4\frac{1}{4}$  to  $4\frac{3}{4}$ , and Westminster Electric Supplies stand at from  $2\frac{1}{2}$  to 3.

**The Chelsea Electricity Supply Company and the Vestry.**—At the last meeting of the vestry, a letter was read from the Chelsea Electricity Supply Company, giving notice of the intention to discontinue the supply of electricity between the hours of midnight and 4 o'clock in the afternoon, and stating that this was a temporary measure made necessary by the continuance for several days of heavy fogs. Mr. H. J. Wright complained bitterly, as a consumer, of this proposal. He stated that the company had already cut off the supply, and on Saturday morning he was without any light at all. He moved that as the company are applying for a further extension of their order of supply, the Board of Trade should be asked to refuse their assent to such application, unless they would compel the company to give a continuous supply, night and day, even during the foggy weather. After further discussion, in which strong things were said, the motion was carried.

**Telephone Management.**—Mr. George J. Summer-ville, who has been manager for the National Telephone Company in the Aberdeen district for the past six years, has been appointed district manager to the Mutual Telephone Company for Lancashire.

**The Belgian Society of Electricians.**—The Belgian Society of Electricians began, on December 4th, its series of public Thursday lectures, on the premises of the Engineers' Society at the Palais de la Bourse, Brussels. The President, M. Wybauw, in a short opening address, set forth the great change which electricity had imported into the study of all the sciences, and how necessary it was for the engineer, with whichever branch he was connected, to keep himself *au courant* with the researches of which this relatively new science was the object. By starting public lectures given by its members, the Belgian Society of Electricians was endeavouring to meet a real want and to facilitate to all the study, longer or shorter, of electricity and its most frequent applications. The lecturer, Capt. Eugène Lagrange (of the Engineers), a professor at the Military School, afterwards gave, with much clearness, an interesting history of electrical science. This lecture, which was embellished with numerous anecdotes, highly interested those present, and formed a promising beginning for the course. The following ones will be accompanied by experimental demonstrations, which cannot fail to add to their success.

**City and South London Railway.**—A correspondent has taken the trouble to send us the following figures :—"Trains every five minutes both ways = 168 trains per day of 14 hours. Fare 2d., average 50 passengers =  $365 \times 168 \times 2 \times 50$

$$\frac{240}{240} = \text{£}25,134, \text{ or gross revenue, say, } \text{£}25,000 \text{ per annum.}$$

On ordinary railways (steam) the expenses are 50 per cent. of the revenue. If this applies to the above the profit may be, with three million passengers per year and a twopenny fare =  $\text{£}12,500, \text{ or } \frac{12,500}{760,000} = 1.8 \text{ per cent. on capital.}$ " Our

correspondent has only based his calculations on one line; he has omitted the return trains, but, on the other hand, his average of 50 passengers on a total train capacity of 100, will be found too high when the company once gets into ordinary everyday work. Perhaps others of our readers may have figured out the probable chances of dividend paying on £760,000 sunk capital?

**Elmore's Foreign and Colonial, &c., Company.**—To everybody interested in this concern we recommend the perusal of a letter signed "Vigilans," which appeared in Tuesday's issue of the *Financial Times*.

**Another Trans-Continental Wire.**—The Western Union has a new wire between San Francisco and New York almost up. It is a Wheatstone automatic circuit, and is intended for California through business exclusively.

**Who is Henry Hickman?**—We extract the following from the *Financial Times* of Monday:—Would Mr. William Elmore have any objection to tell us precisely who is "Henry Hickman, engineer, 51 and 53, Handforth Road, London, S.W.?" We are curious to know, because Mr. Hickman holds 4,660 shares in MacIvor's Patents, Limited, and because he took the trouble to write to us to assert his perfect confidence in the MacIvor process, citing his large holding as proof of his faith. But when Mr. Henry Hickman is written to at the address he gives in the register of shareholders, and which he gave to us, the Post Office returns the letter marked, "No such number, and name unknown in Handforth Road, Stockwell, S.W." Can Mr. Hickman be produced, and, if he can, why does he not give an address that can be traced? Perhaps Mr. Elmore will explain, as we are not disposed to pay much heed to Mr. Henry Hickman's communications.

**Electric Lighting Complaints.**—Mr. R. Chamberlain returns to his attack on the Chelsea Electricity Supply Company, and states that during the recent foggy weather, the potential difference at the lamp terminals has been less than 90 volts. Naturally this leaves one's house very badly lighted, and the chairman of the company attempts to show that the recent continuous fogs have drained the reserves of electricity in the accumulators. He omits to say, however, that this excuse is invalid, because the dynamos ought to be able to supply all the maximum current required at any period. It appears to us that the great drop in E.M.F. shows that at the time of maximum demand the leads are too small, and that sudden strains upon the output of the station, such as now exist, had not been allowed for. To the extraordinary notice which the company has thought it advisable to issue, we refer in our leading columns.

**Crystal Palace School of Engineering.**—The certificates gained by the students of the Crystal Palace School of Practical Engineering during the past term were presented on Saturday afternoon, in the lecture room of the school, by Major F. A. Marindin (Inspector of Railways), who, in the course of his address to the students, specially referred to the large field opening up for engineers in the direction of electricity, "the future of which no one could foretell, and the importance of which it was almost impossible to exaggerate." The results of the examinations showed that the school was advancing in numbers, and, as in past terms, had been distinguished, not more by the ability and energy of the teachers, than by the great earnestness of the students.

**A Lost Opportunity.**—*Modern Light and Heat* says: "It is astonishing by what narrow margins some people escape making large fortunes. It is reported that Prof. Alexander Graham Bell tried again and again to persuade Senator Don Cameron to buy a one-half interest in his invention for \$10,000. Cameron thought Bell a half-witted dreamer, refused to put up a dollar, and finally gave orders that Bell should no longer be admitted to his office. That half-interest to-day would pay a handsome interest of \$10,000,000."

**Reuter's Telegram Company, Limited.**—A meeting was to be held yesterday for the purpose of confirming the resolutions passed at the meeting held on December 6th, and reported in our issue of December 12th.

#### TRAFFIC RECEIPTS

The Brazilian Submarine Telegraph Company, Limited. (The traffic receipts for the week ending December 19th were £6,118.)

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 19th, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited were £4,815.

#### NEW COMPANIES REGISTERED.

**Electric Stores, Limited.**—Capital, £15,000 in £1 shares. Objects: To carry on, either as principals or agents, the business of electrical stores, and for the manufacture and sale of electric, telegraphic, surgical, and scientific instruments. Signatories (with 1 share each): A. L. Martyn, L.R.C.P.L., Saltash; J. R. Davies, 29, Stockwell Park, S.W.; J. R. Davis, Greenwood Road, N.E.; H. R. Pope, Streatham; G. Grant Lobham, 33, Mornington Road, Regent's Park; T. V. Riodan, Cantley House, Clapham Common; R. S. Jennings, Capel Road, Forest Gate. Registered 17th inst., without special articles, by G. D. Freeman, 103A, Paul Street, Finsbury Square. Registered office, 51, Cannon Street.

**New Zealand Electrical Syndicate, Limited.**—Capital, £30,000 in £10 shares. Objects: To acquire charters, concessions, and other privileges for the production, storage, and distribution of electricity in New Zealand, Victoria, New South Wales, North, South or Western Australia, Tasmania, New Guinea, the Fiji Islands, or elsewhere in Australasia, and to take over and work the central stations erected by the Gülcher (New) Electric Light and Power Company, Limited, in Wellington, New Zealand. Signatories (with 1 share each): \*Daniel de Castro, 6, New Square, Lincoln's Inn; Walter Turnbull, Mount Henley, Sydenham Hill; R. Pryor, 79, Gracechurch Street; \*M. S. Vanderbyl, 187, Queen's Gate; \*H. Gröwing, 14, Austin Friar's; James Alexander, 3, Great Winchester Street; W. Farmer, 48, Aldermanbury. The signatories denoted by an asterisk, and J. Evelyn Williams, are the first directors. Registered 20th inst. by Reyroux, Phillips & Co., 99, Cannon Street.

#### OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Nottingham Electric Light and Power Company, Limited.**—The annual return of this company, made up to the 8th inst., was filed on the 18th inst. The nominal capital is £100,000, divided into 9,900 ordinary and 100 founders' shares of £10 each. The shares taken up are 27 founders' and 200 ordinary, but no call has been made, or paid, in respect thereof. Registered office, 22, Low Pavement, Nottingham.

**Electric Trust, Limited.**—By a resolution passed by this company in general meeting on the 10th inst., the capital of the company has been increased by the addition thereto of £200 divided into 200 shares of £1 each, beyond the registered capital of £60,000.

**Woolwich District Electric Light Company, Limited.**—The statutory return of this company, made up to the 17th inst., was filed the same day. The nominal capital is £10,000 in £1 shares; 180 shares are taken up, the full amount has been called thereon, the calls paid amounting to £140 and unpaid to £40. Registered office, 39, William Street, Woolwich.

**Bishop Stortford Electric Light and Steam Laundry Company, Limited.**—The statutory return of this company, made up to the 17th inst., was filed on the same day. The nominal capital is £10,000 in £1 shares; 11 shares have been taken up, and the full amount has been called thereon, but not paid. Registered office, North Street, Bishops Stortford, Herts.

**Swan United Electric Light Company, Limited.**—The annual return of this company, made up to the 9th inst., was filed on the 17th inst. The nominal capital is £1,000,000 in £5 shares; the shares taken up are 78,949 ordinary, and 19,750 considered fully paid; upon the former the sum of £3 10s. per share has been called, the calls paid amount to £279,851 10s. The sum of £3,530 has been paid upon 1,201 shares forfeited.

# RULES AND REGULATIONS OF THE NEW ENGLAND INSURANCE EXCHANGE FOR ELECTRIC LIGHTING.

ADOPTED SEPT. 27TH, 1890, AND SUPERSEDING ALL PREVIOUS  
RULES.

*Revised in Conjunction with Committee from New England  
Electric Exchange.*

## GENERAL REQUIREMENTS.

A CERTIFICATE for all new work or changes in old work (Form "C" for arc, Form "F" for incandescent), should be signed by the party installing or controlling any apparatus. The certificate should be filed with the Secretary of the Local Board of Fire Underwriters having jurisdiction, if there be such; otherwise, with the Secretary of the New England Insurance Exchange, Boston.

This certificate is relied upon as a guaranty until the work can be inspected. Permits for the use of the light or power may be granted as soon as the certificate is duly filed.

Blank certificates may be obtained by application to the Secretary of the New England Insurance Exchange, Boston.

All work should be inspected before any of it is concealed, and to this end notice of concealed work must be given this exchange as soon as work is commenced.

The New England Insurance Exchange reserves the right at any time to add to, change, or modify the accompanying rules, and to enforce such modifications, changes, &c., as it shall deem necessary for safety; and it will use all reasonable efforts to promptly notify all electric light companies of any such change.

Any additional loading of wires, either in a building as a whole, or in any department thereof, without previous notification to the exchange, such as is required, shall be deemed a sufficient cause for the suspension of any permit previously granted, until the same shall have been inspected and approved by this exchange.

This exchange reserves the right to disapprove of the use of any wire, switch, cut-out, or any device, or form of material, which it may consider inconsistent with safety from fire risk, even though it may be proposed to instal the same in conformity with these rules.

The following rules will be strictly enforced, and in no case will a certificate of inspection be issued for work which does not fully comply with the rules in all particulars.

## RULES FOR WIRING.

### *Outside Wires.*

1. Conducting wires carried over or attached to buildings, must be (a) at least 7 feet above the highest point of flat roofs, and (b) 1 foot above the ridge of pitch roofs; (c) when in proximity to other conductors likely to divert any portion of the current, they must be protected by guard irons or wires, or a proper additional insulation, as the case may require.

2. For entering buildings, (a) wires with an extra heavy waterproof insulation must be used, (b) they must be protected by drip loops, (c) also protected from abrasion by awning frames (d) be at least 6 inches apart, (e) the holes through which they pass in the outer wall of such building must be bushed with a non-inflammable, waterproof, insulating tube, and (f) should slant towards the inside.

3. The inspector may, at his discretion, require wires, other than those used for conveying current for electric light or power, entering buildings to be protected by some approved automatic cut-out, in any locality where such wires are, in his opinion, liable to come in contact with electric light or power wires.

4. Converters, and the primary wires leading thereto, (a) must not be placed inside of any building (central stations excepted); (b) they may be attached to the walls on the outside if securely supported by substantial wooden cross pieces or cleats.

5. Wires attached to buildings should be (a) free of contact with the building, and (b) supported by rubber hooks, glass insulators, or porcelain knobs. (Porcelain knobs should be used to support high potential wires.)

### *Inside Wires.*

[High Potential (over 350 volts) Arc and Series Incandescent.]

6. Wires must enter and leave the building (a) at the same place (b) through an approved cut-out switch, which must be (c) mounted on a non-combustible base if attached to any combustible substance (d) kept free from moisture, and (e) easy of access to firemen and police.

7. The cut-out switch must be (a) double-contact (b) must effectually close the main circuit and cut off the interior, when turned "off" (c) so constructed that there shall be no arc between the points when thrown "on" or "off" (d) automatic in its action (not stopping between points when once started) (e) and indicate upon inspection whether the current be "on" or "off."

8. Wires (a) must be rigidly supported (b) on porcelain, glass, or other non-combustible insulators (c) free from contact with the building, (d) have water-proof insulation wherever there is a possible exposure to moisture, (e) be at least 12 inches apart, and (f) at least 3 inches from any other substance capable of acting as a conductor.

9. (a) When wires pass through walls, floors, partitions, &c., (b) or wherever protection from mechanical injury is necessary, (c) they must be protected by glass, hard rubber, or other moisture-proof, non-inflammable tubing. (d) Soft rubber tubing will not be approved.

10. (a) No concealed work (b) or wires fastened with metallic staples will be approved.

11. In perfectly dry places wires (a) supported by wooden cleats, which (b) are "filled" to prevent the absorption of moisture, and (c) have a backing so as to separate the wire at least one-fourth inch from the building, may be approved by the inspector.

12. A wire (a) having a non-inflammable insulation, and (b) be enclosed in a moisture-proof (c) insulating conduit or tubing (d) sufficiently strong to protect the wire from mechanical injury, may be used, in which case the tube may be fastened by metallic loops if desired, and the distance between wires reduced to 3 inches; but (e) the entire "conduit system" must be moisture-tight—i.e., joints and open ends must be sealed with some approved cement.

13. The "series" incandescent lamp must (a) be provided with a proper hand-switch, and (b) an approved automatic device which will shunt the circuit around the carbon filament should it break; (c) it must be suspended from a hanger board by means of a rigid tube, and (d) must not be used in damp or wet places.

14. Any method of distributing current to incandescent lamps on high potential circuits other than as above provided for, must receive the approval of this exchange before being put into use.

15. In arc lamps indoors, (a) the light must be surrounded by a globe with a closed base; (b) the depth of the globe must be such that the point of contact between the carbons, when the lamp is newly trimmed, shall not be less than 3 inches below the upper edge of the globe; and (c) the globe must be enclosed by a wire netting where there is any material under the lamp that could be damaged or ignited by hot cinders, or (d) when the lamp is an "all night" lamp. (e) Where exposed to flyings, or where any inflammable material is suspended near the lamp, spark arresters must be used.

16. Hanger boards for arc or series incandescent lamps must not be used in damp places or wet places.

17. Each arc lamp must be provided (a) with a proper hand switch, (b) with an automatic switch that will shunt the current around the carbons should they fail to feed properly, and (c) with "stops" to prevent the carbons from falling out in case their clamps fail to hold them.

18. The entire installation must test free from grounds.

[Low potential (350 volts or less) incandescent.]

19. For inside work, no wire smaller than No. 14 "B. and S.," or No. 16 "B.W.G.," will be approved.

20. Samples of wire to be used, or in actual use, must be submitted to this exchange, for tests of conductivity or of insulation, at any time when required.

21. (a) Wires must never be left exposed to mechanical injury, or to disturbance of any kind. (b) Wires must not be fastened by metallic staples. (c) When wires pass through walls, floors, partitions, timbers, &c., glass tubing, or so-called "floor insulators," or other moisture-proof, non-inflammable, insulating tubing must be used. (d) At all outlets to and from cut-outs, switches, fixtures, &c., wires must be separated from gas pipes or parts of the building by porcelain, glass, or other non-inflammable insulating tubing, (e) and should be left in such a way as not to be disturbed by the plasterers. (f) Wires of whatever insulation must not in any case be taped or otherwise fastened to gas piping. (g) If no gas pipes are installed at the outlets, an approved substantial support must be provided for the fixtures.

22. In crossing any metal pipes, or any other conductor, (a) wires must be separated from the same by an air space of at least  $\frac{1}{8}$  inch, where possible, and (b) so arranged that they cannot come in contact with each other by accident. (c) They should go over water pipes.

23. Twin wires must not be used except (a) as allowed in "conduit" wiring, (b) or for "pendants," fixture wiring, and "portables." (c) An exception may be made to this rule, by the inspector, where it is necessary to run a short distance, if the wire (d) has a non-inflammable covering, (e) is not concealed, and (f) carries but a small current.

24. The safe carrying capacity of wires when exposed to the air may be taken from the following table:—

B. and S. gauge.	Current in amperes.
0000	300
000	245
00	215
0	190
1	160
2	135
3	115
4	100
5	90
6	80
7	67
8	60
10	40
12	30
14	22
16	15

When wires are enclosed in moulding or otherwise treated so as to prevent cooling by radiation, the carrying capacity is reduced

about 40 per cent., and under such circumstances, or when the wires are installed where the temperature is unusually high, as in boiler rooms, and the like, wires should be fused accordingly.

25. (a) In rooms where inflammable gases may develop, or (b) where the atmosphere is very damp, the incandescent lamps should be enclosed in vapour-tight globes. (c) Switches are not permitted in places filled with inflammable gases, breweries, distilleries, &c., as the spark at make or break might cause explosion. (d) Fusible safety plugs, if necessary in such places, must be enclosed in air-tight, non-combustible cases.

26. Soft rubber tubing will not be approved in cases where these rules require an additional covering to the insulation of the wire.

27. The entire installation must test free from grounds.

#### WIRING.

##### Cleat Work.

28. (a) Cleats made of well-filled, dry, hard wood may be used to support wires not concealed, in perfectly dry places only. (b) They must be so constructed as to separate wires of opposite polarity at least  $2\frac{1}{2}$  inches. (c) Wires must be drawn taut, and cleats placed near enough together to prevent the possibility of contact between the wires.

29. Except on wooden surfaces so filled as to prevent the absorption of moisture (a) the wire must have a waterproof insulation, or (b) the cleats must have a backing that will separate the wire at least  $\frac{1}{4}$  inch from the building.

##### Moulding.

30. Mouldings must not be used (a) in concealed work, nor (b) in places where there is any probable exposure to moisture.

31. (a) Moulding must consist of two parts: viz., a back-piece, which shall separate the wire at least one-fourth inch from the part of the building to which it is fastened, and a cover, one of which parts shall contain the grooves, (b) these grooves to have between them a septum or tongue of wood so as to separate the wires at least one-half inch. (c) The moulding must be coated inside and out with shellac or water-proof paint, or treated in some other manner so as to prevent any possible absorption of moisture. (d) Mouldings with open grooves laid against walls or ceilings will only be approved when such walls or ceilings are of wood, and so filled as to prevent the absorption of moisture.

##### Concealed Work.

32. In unfinished lofts, between floors and ceilings, in partitions, and other concealed places, wires must (a) be kept free of contact with the building, (b) be supported on glass, porcelain, or other non-combustible insulators, (c) have at least one inch clear air space surrounding them, (d) be at least 10 inches apart when possible, and (e) should be run singly on separate timbers or studding. (f) When thus run in perfectly dry places, and liable to be exposed to moisture, a wire having simply a non-combustible insulation may be used.

33. Wires run as above (a) immediately under roofs (b) in proximity to water tanks, or pipes, will be considered as exposed to moisture; and in such places the insulating covering of the wire must consist of a water-proof covering next the wire, protected by an external covering not easily abraded, and that will not support combustion.

34. Wires must not be fished (a) for any great distance, and (b) only in places where the inspector can satisfy himself that the above rules have been complied with. (c) Twin wires must never be employed in this class of concealed work.

##### Conduit Wiring.

35. Wires may also be concealed by means of a system of insulating tubes, or "conduits," that are moisture-proof and practically non-inflammable, and have a threaded joint. (a) A separate tube must be provided for each wire, except (b) in case of taps or branches carrying a current that does not exceed 15 amperes, in which case a flexible twin cable may be used; but (c) the two conductors of this cable must not be insulated from each other by a rubber compound. A cotton or other fibrous covering should be used, and (d) the joints between sections must be made moisture proof, with some cement proper for the purpose; i.e., the whole system must be free from joints, cracks, &c., where it would be possible for moisture to enter the tubing.

36. These tubes may be secured by metallic loops, and may be laid side by side.

37. This is the only manner in which wires may be run imbedded in plaster, cement, or any similar material. Wires run on brick walls or below timbers furred for lath and plaster will be considered as imbedded in plaster, unless the furring strips are of such thickness as to prevent any contact between the wire and the clinches of plaster.

##### Wires in Damp Places.

38. In dye houses, paper and pulp mills, and other buildings especially liable to moisture, all wires, except those used for pendants, must (a) be separated at least 6 inches, (b) be thoroughly and carefully put up, and (c) be supported by glass or porcelain insulators, or by rubber hooks.

39. Where it is necessary to run the wires down a side wall in order to pass through a floor, the wires must (a) be supported from the ceiling to the floor on insulators, (b) placed, if necessary, on a back board, and (c) to protect the wires from injury, they should be boxed over from the floor to a point 5 or 6 feet above.

40. Where exposed to acid fumes, vapors of ammonia, &c., wires should (a) be provided with an insulation, and (b) supported on insulators that will not be injured thereby.

In places covered by Rules 38 and 40, wires may be run under rules for "conduit" wiring, and if to be concealed they must be so run, but in either case will be subject to special approval by the inspector.

#### FITTINGS AND APPARATUS.

##### Safety Cut-outs.

42. (a) Every portion of each installation must be equipped with safety cut-outs, that will interrupt the passage of a current in excess of the amount which that portion of the apparatus is adequate to transmit. (b) Fusible leads designed to carry a current of 10 amperes or over must have contact surfaces of some harder material. (c) Fusible leads should be proportioned to the capacity of the wire they are to protect, and not to the number of amperes required to supply the lamps on that particular circuit. (d) A cut-out must be placed where the underground or overhead service joins the inside wires, and (e) at every point where a change is made in the size of the wire (unless the cut-out in the larger wire is intended to protect the smaller). (f) A cut-out must be provided for each fixture, and (g) in concealed wiring, for each pendant also; but (h) where the wires are exposed, one cut-out may be employed to protect two or more pendants, provided (i) the amount of current they require does not exceed 7 amperes. (j) Stiff brackets not attached to gas pipes may be treated as pendants in this connection.

43. All cut-out devices must (a) be made of non-combustible material, and (b) be placed so as to protect both sides of the circuit, and (c) be provided with close-fitting covers.

44. When lights are grouped, as upon electroliers, &c., the small wires to each light cannot always have cut-outs. Care should be taken, however, that the least controlling cut-out (a) carries as small an amount of current as practicable, and (b) that it will act before the smallest wire runs any risk of being unduly heated.

##### Switches.

45. All switches must (a) be composed entirely of non-combustible material, and (b) be automatic in action.

46. All switches must be double-pole, in circuits (a) connected to fixtures attached to gas pipes, or (b) carrying a current of 10 amperes or over.

##### Pendants, Portables, &c.

47. (a) Lamps may be suspended by flexible cord pendants not less than No. 16 B. and S. or No. 18 B.W.G. (b) Where it enters the lamp socket, the cord must be protected by a bushing of rubber, wood, or some similar insulating material, and (c) the cord must be so arranged that the weight of the lamp, &c., shall not be borne by the joints or binding screws.

48. (a) The covering of the flexible cord, as a whole, shall be of such a nature that it will not support combustion, (b) in damp places the cord must have a moisture-proof covering, and (c) the openings at the top of the socket must be closed, so as to prevent the entrance of water. (d) The flexible leads of the portable fittings must in all cases be protected by cut-outs at their fixed points of connection.

##### Fixtures.

49. (a) Each fixture to which wires are attached must be insulated from the piping of the building by an insulating joint. (b) Burrs and sharp edges must be removed before wires are drawn into a fixture. (c) Wires attached to, or concealed within fixtures, must have an insulating covering that cannot be easily cut or abraded, and (d) that is moisture proof; (e) where attached to the outside of a gas fixture, the conductors must be so secured that their covering will not be cut or abraded by the swaying of the fixture or the movement of the bracket arm. (f) The difference of potential between any two wires connected with a combination or gas fixture, must not exceed 125 volts. (g) No wire smaller than No. 16 B. and S. or No. 18 B.W.G. must be used in fixture wiring.

##### Electric Gas Lighting.

50. Where electric gas lighting is to be used on the same fixture with the electric light (a) no part of the gas piping or fixture shall be in connection with the gas lighting circuit; (b) the wires used for the fixture must have a non-inflammable insulation, or (c) if concealed between the pipes, and a shell of the fixture, must have an insulation such as is required for fixture wiring for the electric light; (d) the whole installation must test free of grounds, and (e) the two installations must test perfectly free of connection with each other. (f) Any such installation will then be subject to special approval by the inspector.

##### Arc Lights on Low Potential Circuits.

51. This system of lighting will in general be governed by the foregoing rules for low potential work, but (a) no wire smaller than No. 12 B. and S. must be used; (b) there must be a double pole cut-out at the junction of the branch with the main, and (c) a double pole switch in the branch. (d) The cut-out, switch, and resistance device must be composed of non-inflammable material. (e) The light must be protected by a globe, &c., the same as is required for a high potential lamp.

## ISOLATED PLANTS.

52. In isolated plants, (a) the dynamo, regulating devices, switchboards, and all wires connecting the same, must be installed in conformity with the requirements for a standard central station (see 53 to 67), and (b) should never be placed in any room where they will be exposed to flyings of any combustible materials.

*Dynamos.*

53. (a) Insulated on thoroughly dry wood, (b) "filled" to prevent absorption of moisture. (c) A waterproof cover should be provided, and kept over each dynamo when not running.

*Wires.*

54. (a) Wires from dynamos to switchboard, and (b) thence to outside lines (bus wires, feeders, primary mains, arc circuit leads and returns) (c) to be wholly exposed to view (d) supported by glass or porcelain insulators, and (e) of sufficient sectional area to prevent heating. (f) Where passing through floors, partitions, or other woodwork, (g) to be protected by substantial tubes of glass or porcelain, (h) which shall project above and below floors, and beyond the surface of partitions, so as to insure perfect insulation. (i) Hard rubber tubing may be used, except where passing through the floors at or near the dynamo.

55. (a) Where leaving the building, the wires to be looped downward, and (b) the tubes in which they are enclosed to be inclined so as to prevent the entrance of rain water along the wires.

56. (a) Wires of opposite polarity should be separated at least 12 inches, (b) particularly where passing through floors and partitions. (c) Conductors from ceiling or floor to switchboard may be run at less distance than 12 inches from each other, (d) but in that case an approved insulation must be provided.

57. If (a) conductors from dynamos are run under floors, (b) except the space underneath be a perfectly dry finished room, and (c) not less than 6 feet between floors, (d) they must be specially insulated and will then be subject to approval.

58. (a) Each feeder and primary main to be provided with a safety fuse on a non-combustible base. (b) All wire connections must be soldered, if necessary, to secure good contact.

59. Branch wires for station lighting to be in accordance with the requirements of this exchange for electric light wiring.

*Switchboards.*

60. (a) To be kept free from moisture (b) located apart from wood work (c) accessible from all sides (d) not enclosed, and (e) with all electrical devices, wires and connections in plain sight. (f) When all wires and electrical devices are on the front, the switchboard may be set against a brick wall (g) but must be detached from any wood work. (h) The switchboard should be constructed either of slate or some other non-combustible insulating substance, or (i) so-called "skeleton."

61. (a) All switches and wires on the switchboard must have ample capacity and (b) contact to carry their possible maximum load without heating.

*Lightning Arresters.*

62. (a) To be located in sight of attendants, and (b) so placed and constructed that an arc if formed will not come in contact with wood work or other combustible material. (c) Lightning arresters should be so designed as to automatically destroy any arc which may be formed by a lightning discharge or otherwise.

*Equalisers.*

63. (a) Frames to be constructed of non-combustible material. (b) To be open and accessible from all sides (c) supported at least 12 inches from all wood work (d) and located so as to be in sight of dynamo attendant.

64. (a) All resistance devices to be so designed as to heat but slightly when in use, and (b) connected so as not to be liable from a short circuit or other cause to an over charge of current; (c) otherwise they must be enclosed in non-combustible cases and (d) kept away from any woodwork.

*Care and Attendance.*

65. A competent man must be kept constantly in the dynamo room while the dynamos are running.

66. (a) Oil must not be allowed to accumulate on the floor, and (b) all oily waste must be kept in standard metal waste cans, or (c) removed from the station daily after the dynamos are stopped and cleaned.

67. Arc lamps must always be provided with perfect globes.

## MOTORS.

68. Motors must (a) be placed as near as possible to the point where wires enter the building (b) be mounted on filled, dry wood, (c) be raised at least 8 inches above the surrounding floor, (d) be kept clean, and (e) covered with a waterproof cover when not in use, and (f) if deemed necessary by the inspector, be enclosed in an approved case.

69. Standard metal waste cans, with a self-closing cover and legs raising the can at least 3 inches from the floor, must be provided for oily waste.

*Switches, Regulators, and Cut-outs.*

70. (a) The controlling switch must be so constructed as to entirely disconnect the motor from the circuit, and (b) a cut-out such as is required for a similar lighting circuit must be placed

as near as possible to the point where the wires enter the building.

71. All switches, regulators, cut-outs, &c., must (a) be as nearly non-combustible as possible, (b) be protected from moisture, (c) have a backing of porcelain, slate, cement, asbestos, or other equally non-combustible substance, and (d) be perfectly insulated.

*Wiring.*

72. (a) Wire having a waterproof insulation must be used. (b) The wire must be rigidly supported (c) on porcelain, glass or other non-combustible insulators, free from contact with the building, and (d) at least 6 inches apart. (e) No concealed work, (f) cleat work, or (g) wires fastened with metallic staples, will be approved.

73. (a) when wires pass through walls, floors, partitions, &c., or (b) wherever protection from mechanical injury is necessary, (c) they must be protected by glass, hard rubber, or other moisture proof, non-inflammable tubing. (d) (Soft rubber tubing will not be approved.)

74. These rules are not intended to preclude the running of small motors (for fans and the like) on low potential lighting circuits, the installation of which has received the approval of the inspector.

75. The entire installation must test free from grounds; but motors run on a "ground circuit" may be approved by the inspector, under these rules, provided the return wire is carried to a ground outside of the building.

## LIGHTING FROM GROUND RETURN POWER CIRCUITS.

76. Electric railway power stations and their car sheds may be lighted by incandescent lamps connected with their power wires, if the installation of the wires meets with the approval of the inspector, but no other property may be so lighted.

## MISCELLANEOUS.

77. Splices in both arc and incandescent circuit wires must be made so that a perfectly secure and unvarying connection, fully equal to the cross section of the wire will be secured. The splice must be soldered, but solder must never be employed to complete a joint that would be loose or insecure without it. Either resin or an acid solution may be used as a flux; both are objectionable if not carefully applied.

78. Architects are urged to familiarise themselves with these rules, and to see that all contracts are made subject to the work being done in accordance therewith, and also to see that it has so done. The New England Insurance Exchange will gladly aid them to this end by giving information, advice, or inspection to as great an extent as possible.

79. A great danger in all installations is from poor contacts; consequently, avoid screw joints as much as possible; screw them up tight, with good areas of contact; on no account allow them out of sight. Solder every connection as far as practicable.

80. When an electrical fire breaks out, turn off the current at the nearest switch, or sever the conductors (one at a time); then use your appliances. The injudicious use of water without these precautions may only increase the extent of the fire. In severing the conductors of high electromotive force, be careful that you stand on a good insulator, such as dry wood, and that the handle of your hatchet is dry, or personal injury may result.

## PROCEEDINGS OF SOCIETIES.

## Physical Society.—December 12th, 1890.

Prof. W. E. AYRTON, President, in the Chair.

Mr. SHELFORD BIDWELL, F.R.S., showed "Some Experiments with Selenium Cells." The crystalline variety of selenium was, he said, most interesting to physicists owing to its electrical resistance being greatly diminished by light. This property was shown experimentally with different forms of cells, the construction of which were explained. The form recommended was that in which two copper wires are wound near each other round a slip of mica, and the spaces between the wires filled with selenium. The wires form the terminals of the so-called "cell," which, before being used, is annealed for several hours at a temperature above 200° C. Many such cells were made in 1880, 1881, and their sensitiveness to light remained unimpaired during 1882. In 1885, however, several were found less sensitive, and others totally useless; only one out of thirteen retained its sensibility till September, 1890. The loss of sensitiveness Mr. Bidwell believes due to an excessive amount of selenide of copper being formed, for although some selenide is essential to the satisfactory working of the cell, too much is fatal to its action. The selenide of one defective cell was electrolysed, red tufts of amorphous selenium appearing on the anodes. A white substance resembling moist calcium chloride was also present; this he believed to be oxide or hydroxide of selenium. Small polarisation currents had been obtained from selenium cells.

A lecture apparatus illustrating the properties of selenium cells was exhibited. It consisted of a cell connected in series with a relay and a battery. The relay was arranged so that it might

either ring a bell or light an incandescent lamp. When the bell was joined up, it remained silent so long as the selenium cell was illuminated, but on screening the cell, the bell rang. By using various coloured glasses as screens, the effect was shown to be due to the red and yellow rays. A similar experiment with the glow lamp was very striking, for, on turning down the gas lamp illuminating the cell, the electric lamp lighted, and was extinguished on turning up the gas. This demonstrated the possibility of an automatic lamp-lighter which would light or put out lamps according as they are required or superfluous. Amongst the other practical applications suggested were, announcing the accidental extinction of railway signal lamps or ships' lights, and the protection of safes and strong rooms.

Prof. MINCHIN said he had lately constructed cells of a different kind to those shown by Mr. Bidwell, and found that they gave an E.M.F. when exposed to light. For his purposes the long annealing, &c., were quite unnecessary, and a complete cell could be made in 10 minutes. One of his cells gave an E.M.F. of over 1 volt as measured by an electrometer, by the light of a fog. Their promptness of action falls off in a day or two, but if they are kept on open circuit, a week has no effect on the final E.M.F. On closed circuit, however, they deteriorate.

Prof. S. U. PICKERING said both oxides of selenium were deliquescent, and the author's conclusion as to the white substance formed by electrolysis was probably correct.

Prof. S. P. THOMPSON believed Prof. Graham Bell had tried platinum instead of copper, and found that the selenium cracked off in annealing. He also found that it was only necessary to carry on the annealing until the characteristic slate colour appeared. Mr. Bidwell's experiments, he said, showed the possibility of seeing at a distance, and had also suggested to him that the effect of screening might be utilised for driving a completely detached pendulum electrically.

Prof. FORBES said that silver sulphide, when electrolysed, presented appearances resembling those noticed by Mr. Bidwell in copper selenide.

In reply to questions from the PRESIDENT and Prof. PERRY as to whether the low resistance and unsensitiveness of old cells was due to moisture, Mr. BIDWELL said drying them had no effect, but baking restored the resistance, but not their sensitiveness. Speaking of the effect of annealing cells, he said this reduced their resistance considerably. Prof. Graham Bell, he believed, gave up using platinum because the resistances of such cells were very high.

Mr. JAMES SWINBURNE read a paper on "Alternate Current Condensers." It is, he said, generally assumed that there is no difficulty in making commercial condensers for high pressure alternating currents. The first difficulty is insulation, for the dielectric must be very thin, else the volume of the condenser is too great. Some dielectrics, 0.2 mm. thick, can be made to stand up to 8,000 volts when in small pieces, but in complete condensers a much greater margin must be allowed. Another difficulty arises from absorption, and whenever this occurs, the apparent capacity is greater than the calculated. Supposing the fibres of paper in a paper condenser to be conductors embedded in insulating hydrocarbon, then every time the condensers is charged, the fibres have their ends at different potentials, so a current passes to equalise them, and energy is lost. This current increases the capacity. One condenser made of paper boiled in ozokerite took an abnormally large current, and heated rapidly. At a high temperature it gave off water, and the power wasted and current taken, gradually decreased. When a thin plate of mica is put between tin foils, it heats successively, and the fall of potential over the air films separating the mica and foil is great enough to cause disruptive discharge to the surface of the mica. There appears to be a luminous layer of minute sparks under the foils, and there is a strong smell of ozone. In a dielectric which heats, there may be three kinds of conduction, viz., metallic, when an ordinary conductor is imbedded in an insulator; disruptive, as probably occurs in the case of mica; and electrolytic, which might occur in glass. In a transparent dielectric, the conduction must be either electrolytic or disruptive; otherwise light vibrations would be damped. The dielectric loss in a cable may be serious. Calculating from the waste in a condenser made of paper soaked in hot ozokerite, the loss in one of the Deptford mains came out 7,000 watts. Another effect observed at Deptford is a rise of pressure in the mains. There is, as yet, no authoritative relative statement as to exactly what happens, and it is generally assumed that the effect depends on the relation of capacity to self-induction, and is a sort of reso-

nator action. This would need a large self-induction, and a small change of speed would stop the effect. The following explanation is suggested. When a condenser is put on a dynamo the condenser current leads relatively to the electromotive force, and therefore strengthens the field magnets, and increases the pressure. In order to test this the following experiment was made for the author by Mr. W. F. Bourne. A gramme alternator was coupled to the low pressure coil of a transformer, and a hot-wire voltmeter put across the primary circuit. On putting a condenser on the high pressure circuit the voltmeter wire fused. The possibility of making an alternate excite itself, like a series machine, by putting a condenser on it, is pointed out.

Professor PERRY said it would seem possible to obtain energy from an alternator without exciting the magnets independently, the field being altogether due to the armature currents.

Mr. SWINBURNE remarked that this could be done by making the rotating magnets a star-shaped mass of iron.

Sir W. THOMSON thought Mr. Swinburne's estimate of the loss in the Deptford mains was rather high. He himself had calculated the power spent in charging them, and found it to be about 16 horse power; and although a considerable fraction might be lost, it would not amount to nine-sixteenths. He was surprised to hear that glass condensers heated, and inquired whether this heating was due to flashes passing between the foil and the glass.

Mr. A. P. TROTTER said Mr. Ferranti informed him that the capacity of his mains was about one-third microfarad per mile, thus making  $2\frac{1}{3}$ rd microfarads for the seven miles. The heaping up of the potential only took place when transformers were used, and not when the dynamos were connected direct. In the former case the increase of volts was proportional to the length of main used, and 8,500 at Deptford gave 10,000 at London.

Mr. BLAKESLEY described a simple method of determining the loss of power in a condenser by the use of three electro-dynamometers, one of which has its coils separate. Of these coils, one is put in the condenser circuit, and the other in series with a non-inductive resistance  $r$ , shunting the condenser. If  $a_2$  be the reading of a dynamometer in the shunt circuit and  $a_3$ , that of the divided dynamometer, the power lost is given by  $r(ca_3 - ba_2)$ , where  $b$  and  $c$  are the constants of the instruments on which  $a_2$  and  $a_3$  are the respective readings.

Prof. S. P. THOMPSON asked if Mr. Swinburne had found any dielectric which had no absorption. So far as he was aware, pure quartz crystal was the only substance.

Prof. FORBES said Dr. Hopkinson had found a glass which showed none.

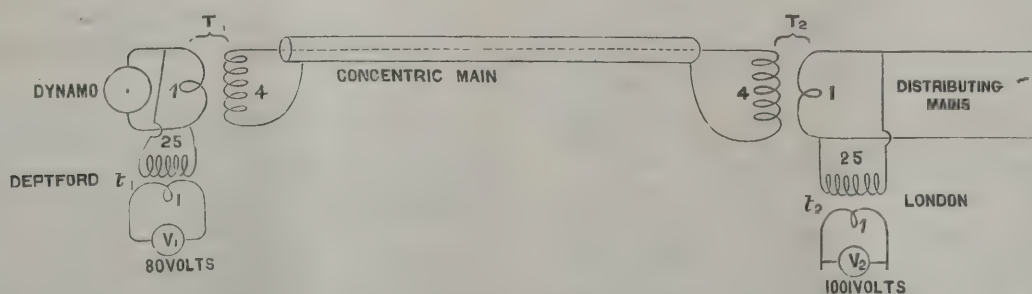
Sir W. THOMSON, referring to the same subject, said that many years ago he made some tests on glass bottles, which showed no appreciable absorption. Sulphuric acid was used for the coatings, and he found them to be completely discharged by an instantaneous contact of two balls. The duration of contact would, according to some remarkable mathematical work done by Hertz in 1882, be about 0.0004 second, and even this short time sufficed to discharge them completely. On the other hand, Leyden jars with tinfoil coatings showed considerable absorption, and this he thought due to want of close contact between the foil and the glass. To test this, he suggested that mercury coatings be tried.

Mr. KAPP considered the loss of power in condensers due to two causes; first, that due to the charge soaking in, and second, to imperfect elasticity of the dielectric. Speaking of the extraordinary rise of pressure on the Deptford mains, he said he had observed similar effects with other cables. In his experiments, the sparking distance of a 14,000-volt transformer was increased from  $\frac{1}{10}$ th of an inch to one inch by connecting the cables to its terminals. No difference was detected between the sparking distances at the two ends of the cable, nor was any rise of pressure observed when the cables were joined direct on the dynamo. In his opinion, the rise was due to some kind of resonance, and would be a maximum for some particular frequency.

Mr. MORDEY mentioned a peculiar phenomenon observed in the manufacture of his alternators. Each coil was tested to double the pressure of the complete dynamo, but when they were all fitted together, their insulation broke down at the same volts. The difficulty had been overcome by making the separate coils to stand much higher pressures.

Prof. RÜCKER called attention to the fact that dielectrics alter in volume under electric stress, and said that if the material was imperfectly elastic some loss would result.

The PRESIDENT said that as some doubt existed as to what Mr. Ferranti had actually observed, he would illustrate the arrangements by a diagram:—



Explanation of Diagram:— $T_1$  and  $T_2$  are large transformers;  $t_1$  and  $t_2$  are small transformers for voltmeters,  $V_1$  and  $V_2$ . The numbers 1, 4, 1, 25, represent their conversion ratios.

Speaking of condensers, he said he had recently tried lead plates in water to get large capacities, but, so far, had not been successful.

Mr. SWINBURNE, in replying, said he had not made a perfect condenser yet, for although he had some which did not heat much, they made a great noise. He did not see how the rise of pressure observed by Mr. Ferranti and Mr. Kapp could be due to resonance. Mr. Kapp's experiment was not conclusive, for the length of spark is not an accurate measure of electromotive force. As regards Mr. Mordey's observation, he thought the action explicable on the theory of the leading condenser current acting on the field magnets. The same explanation is also applicable to the Deptford case, for when the dynamo is direct on, the condenser current is about 10 amperes, and this exerts only a small influence on the strongly-magnetised magnets. When transformers are used, the field magnets are weak, whilst the condenser current rises 40 amperes.

Mr. BLAKESLEY's method of determining losses was, he said, inapplicable except where the currents were sine functions of the time, and consequently could not be used to determine loss due to hysteresis in iron, or in a transparent dielectric.

Mr. SWINBURNE's "Note on Electrolysis" was postponed till next meeting.

### NEW PATENTS—1890.

19033. "Improvements applicable to switches used for electrical purposes." WOODHOUSE and RAWSON, Limited. (Communicated by A. W. T. Hinde, Australia.) Dated November 24.

19034. "Improvements in automatical electrical apparatus." R. J. JONES and WOODHOUSE and RAWSON, United, Limited. Dated November 24.

19035. "Improvements in dynamos for firing explosive charges or for medical purposes." F. W. DODD. Dated November 24.

19037. "Means of neutralising or controlling the polarity of iron or steel for the protection of magnetic needles from local attraction." J. S. GISBORNE. Dated November 24.

19049. "Improvements in electric lighting appliances for photographic and other purposes." F. L. MUIRHEAD. Dated November 24.

19052. "Improved combination of ingredients constituting a compound as an illuminating medium for electric incandescent lamps." M. N. MALLISON. Dated November 24.

19057. "Improvements in electric arc lamps." W. P. THOMPSON. (Communicated by R. H. Beach, United States.) Dated November 24. (Complete.)

19076. "Improvements in electric safety fuses." W. M. MORDEY. Dated November 24.

19079. "Electric cables." J. ARMSTRONG. Dated November 25.

19083. "An automatic electrical latitudinal indicator and ships' course registering compass." J. O'NIEL. Dated November 25. (Complete.)

19097. "Improvements in and in the method of manufacturing incandescent electric lamps and other exhausted receivers." A. M. CLARK. (Communicated by A. Bernholdt and J. Glatz, United States.) Dated November 25. (Complete.)

19108. "Improvements in or connected with combinations of hydraulic, pneumatic, and electric means for obtaining, transmitting, and applying motive power." C. ADAMS-RANDALL. Dated November 25.

19155. "Improvements in electrical storage batteries or accumulators." H. H. LAKE. (Communicated by G. E. Hatch, United States.) Dated November 25. (Complete.)

19162. "Improvements in methods of electric welding and metal working." M. W. DEWEY. Dated November 25. (Complete.)

19191. "Improvements in and relating to underground electric tramways." M. WHELESS and S. E. WHEATLEY. Dated November 25. (Complete.)

19203. "Improvements in the manufacture of thin metal tubes by electrolysis." L. HAUSMANN. Dated November 25.

19234. "A method of and apparatus for controlling gas lighting in cases of failure of electric light installations." H. C. SWINDELL. Dated November 26.

19239. "Improvements in electric switches." H. BARTON. Dated November 26.

19272. "Electric soldering irons." C. E. CARPENTER. (Date applied for under Patents Act, 1883, Sec. 103. May 10th, 1890, being date of application in United States.) Dated November 26. (Complete.)

19308. "Improvements in and connected with electrical distribution of power by alternating currents, and their measurement." J. SWINBURNE. Dated November 27.

19315. "Improvements in electric arc lamps." H. NUNNS. Dated November 27.

19344. "Improvements in electrolysis in general, and particularly in electrolysis of metals." E. PLACET and J. BONNET. Dated November 27.

19345. "Improvements in suspension devices for incandescent lamps." A. J. BOULT. (Communicated by H. Rentzsch, Germany.) Dated November 27.

19355. "An improved electrical connection or plug." S. BACON. Dated November 27.

19406. "Improvements in electric current meters." E. HARTMANN and W. BRAUN. Dated November 28. (Complete.)

19418. "Improvements in electrical tell-tales for twin-screw steamers." G. HANNAH. Dated November 28.

19423. "Improvements in apparatus for the electrolytic production of gases." E. A. DUCRETET. Dated November 28.

19467. "Improved electric arc lamp." J. P. BAYLY. (Communicated by A. Wagnière, U.S.A.) Dated November 29.

19485. "Automatic railway signalling by electricity." H. E. G. EARLE. Dated November 29.

19496. "Improvements in insulators." J. F. MUNSIE. Dated November 29. (Complete.)

19504. "Improvements in systems of electrical distribution." W. S. RICHARDS and G. B. JAMES. Dated November 29.

19505. "Improvements in the method of, and in the machinery for, the manufacture of lead or metallic boxes and plates for electric accumulators, and other kinds of lead or metallic boxes, plates, tubes, rods and strips of irregular section, or plain, ribbed, corrugated and fluted by hydraulic pressure." A. WYLIE. Dated November 29.

19552. "Improvements in telephonic apparatus, the improved magnets of which may be used in other electrical apparatus or machinery." R. H. COURTENAY. Dated December 1.

19555. "A portable room for telephone." F. A. OETZMANN. Dated December 1.

19601. "Connecting and regulating telegraph, telephone, or electric lighting wires." W. GRIFFITHS. Dated December 2.

19650. "Improvements in the distribution of electricity through accumulator batteries." SIEMENS BROTHERS & CO., LIMITED. (Communicated by Siemens and Halske, Germany.) Dated December 2.

19665. "Improvements in and relating to electro-magnetic traction increasing apparatus for railways." M. W. DEWEY. Dated December 2. (Complete.)

19724. "Improvements in carriers, supports, or galleries, for the shades or globes of electric lights or gas lamps." V. SILBERBERG. Dated December 3.

19740. "Improvements in column printing telegraph receivers." F. H. W. HIGGINS. Dated December 3.

19744. "Improvements in and relating to electric belts and similar appliances." C. B. HARNESS. Dated December 3. (Complete.)

19762. "Improvements in and connected with electrically indicating pressure gauges." W. C. MORISON. Dated December 4.

19806. "Improvements in circuit controllers or switches for incandescent electric lamps." N. MARSHALL. Dated December 4. (Complete.)

19811. "Improvements in apparatus for use in propelling vehicles by electricity." F. WYNNE. Dated December 4.

19813. "Improvements in the production and distribution of alternate electric currents." A. GAY, W. F. TAYLOR and R. HAMMOND. Dated December 4.

19834. "Improvements in controlling levers of railway signal interlocking apparatus for the application of electricity." W. F. BURLEIGH. Dated December 5.

19840. "Transforming paper or other wrapping material into sufficient strength or pertinacity to use as an insulator in all electrical matters and cables." W. EDWARDS and W. SANDBACH. Dated December 5.

19842. "Improvements in roses for ceilings and wall connectors, for electrical purposes." W. H. STURGE and J. GRUEB. Dated December 5.

19883. "Improvements in or relating to self-controlling electrical signals for the prevention of railway accidents." L. CAPOCCI, C. PICONE and A. SPACAGNA. Dated December 5.

19942. "Improvements in galvanic batteries, and in the electro-chemical formation of chlorine and chlorine compounds applicable for such batteries and other purposes." W. P. THOMPSON. (Communicated by F. Marse, Germany.) Dated December 5. (Complete.)

### ABSTRACTS

#### OF PUBLISHED SPECIFICATIONS 1889.

16237. "Improvements in electrical mains and in their manufacture." S. Z. DE FERRANTI. Dated October 15. 8d. In order to insulate the several lengths of the rods or tubes, the inventor winds around each length a sheet or sheets of paper soaked in an insulating material, say, for example, melted paraffin, and this he does by rotating the rod or tube and causing it to wind the paper around itself. He uses sheets of paper each of a length equal to the length of the rod or tube to be covered and of any convenient width so that when wound on to the rod or tube the several layers of paper may be complete in themselves and uniform insulation be obtained throughout the length of the rod or tube. 12 claims.

17142. "Improvements in electro-magnetic induction apparatus for transformers, generators, or motors." L. BOLLMANN. Dated October 29. 8d. Relates to certain parts termed magnetic locks, which might be either of two kinds. A lock of the one kind is a movable piece of iron which in one position forms part of a magnet and in another position makes a break of the magnet so that as the magnetic circuit is thus closed or opened, electric currents are induced in coils surrounding the magnet or parts of it. A lock of the other kind is also a piece of iron forming part of a magnet but of smaller diameter than the body of the magnet itself, and surrounded by a coil through which electric currents can be transmitted in either direction. When they pass in the one direction the magnetic circuit is virtually closed; when they pass in the other direction, that circuit is virtually opened. Thus by alternations of current in the coil of the lock, which remains itself stationary, inductions are caused as in the case where a movable lock of the former kind is employed.

18193. "Improvements relating to the manufacture of insulators and other glass articles and to apparatus for use in such manufacture." DAN RYLANDS. Dated November 14. 11d. Has for its object the manufacture or moulding, more rapidly than hitherto and by labour-saving apparatus, of glass articles and especially of such articles as require a large body of glass in proportion to their size, as, for instance, insulators, insulating jockeys, and other articles in glass were made principally if not altogether by casting, moulding or pressing the glass in suitably-shaped moulds. 4 claims.

18350. "Improvements in dynamo-electric machines." J. H. DAVIES. Dated November 16. 8d. Consists in placing two separate circles of commutator segments on the spindle of the machine arranged and connected as if from an ordinary commutator every alternate segment was removed and displaced longitudinally on the spindle until it was beyond the original commutator, the gaps between the segments in both circles being preferably filled with insulating material such as mica or glass. 2 claims.

18755. "Improvements in the manufacture of plates for use in secondary batteries or electrical accumulators." A. RECKENZAUN. Dated November 22. 6d. The inventor places a plate of lead or other suitable metal in contact with one pole of a dynamo or other generator of electricity, and causes the plate to travel under a conducting point, or allow the conducting point to pass over the surface of the said plate. 2 claims.

18841. "Improvements in apparatus for laying and picking up submarine cables." G. DRAPER and P. L. ISAAC. Dated November 23. 1s. 1d. In place of bolting to the deck a number of girders with spaces between, the inventors employ a single steel casting which may taper from the bow to aft, and to the front of this casting they bolt a number of plates or steel castings technically known as "whiskers" projecting over the water and separating and supporting the sheaves in a similar manner to the girders. At each side of the apparatus they place a horizontal grating supported by the two outside whiskers. 5 claims.

19011. "Improvements in dynamo-electric machines." J. HOPKINSON. Dated November 26. 8d. It is usual to construct the cores of the armatures of dynamo machines of plates of iron insulated from each other. These plates are in the form of rings and when of large size are expensive. The inventor attains the same effect as is obtained by entire rings both magnetically and mechanically by employing segments of rings arranged in layers the joints between the segments breaking joint between successive layers. The friction between the plates is sufficient to keep them in place just as well as if they were entire rings. When a high tension is required he winds the conductor on the following principle, for example, suppose there be 12 poles he winds a number of sections on the armature then advances one-sixth part of the circumference and winds a like number then advances another sixth part and wind on, and so on, until the whole is wound. 2 claims.

19190. "Improvements in and relating to induction coils and electro-magnets." E. L. LOVELL and A. F. LLOYD. Dated November 29. 6d. Upon a centre formed either of a solid soft iron pin or of a bundle of soft iron wires, the inventors wind one or more layers of insulated wire preferably also of soft iron. Upon this coil of wire is disposed a split tube of soft iron, or preferably a plate of ferrotype iron, bent into a cylindrical form, which, serving as an electro-magnetic condenser, would be secured by a cap attached to each end of the soft iron pin above mentioned or by equivalent means. 2 claims.

19199. "Improved means for the prevention of polarisation in electric batteries." H. BADCOCK, H. GRUNSELL and A. WALKER. Dated November 29. 6d. Polarisation in electric batteries is prevented by imparting a continuous or periodical motion or disturbance to the liquid, the invention being primarily intended to be used with bichromate of potash batteries. 1 claim.

19525. "Improvements in electricity meters." W. H. SCOTT and L. PARIS & SCOTT, LIMITED. Dated December 5. 8d. Consists of modifications and improvements to the apparatus described in Letters Patent dated 1888, No. 16,623. 7 claims.

19554. "Improvements in the connections of alternating current generators and electric motors." M. VON DOLIVO-DOBROWOLSKY and "ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT." Dated December 5. 11d. The different coils, instead of being independent, are conductively connected together in each machine,

and the connections between the respective coils of the two machines are such that the coils of the generator supply electric impulses to two or more of the connecting wires or mains simultaneously, though these impulses vary in degree relatively to each of them, and that each impulse transmitted through a main is distributed upon two or more coils of the motor. 2 claims.

19555. "Improvements in electrical induction apparatus or transformers." M. VON DOLIVO-DOBROWOLSKY and the Company "ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT." Dated December 5. 8d. Claim:—An induction apparatus consisting in a number of cores of iron forming together three or more closed or nearly-closed magnetic systems, primary and secondary coils placed on said cores, electric circuits connected to the primary coils, and means for creating in the said circuits alternating currents of successive phases, for the purpose of causing a continuously-progressive shifting of the magnetic axis and maintaining nearly constant the total amount of magnetism, substantially as described.

19831. "Quick make and break electric switches." C. M. DORMAN and R. A. SMITH. Dated December 10. 8d. Claim:—In switches of the quick make and break class described and shown in the specification of Belna Egger, A.D. 1887, No. 5092, the method of attaching either directly to the handle moved by the operator or to mechanism suitably geared thereto one or more parts so arranged as to positively transmit the motion of the handle to the contact lever in either making or breaking contact and so render the switch effective if from any reason the force of the spring or springs is insufficient to overcome the friction of the switch, substantially as described and shown in the drawings.

19951. "Improvements in electrical switches." H. BAYLEY. Dated December 11. 8d. Has for its object the construction of electrical switches in such manner that the contact pieces (or contact makers and breakers) may make and break contact with the terminal plates or blocks simultaneously over the entire bearing area between such parts and be also capable of rubbing contact therewith. 5 claims.

20856. "Improvements in elements for voltaic batteries." D. G. FITZGERALD and A. H. HOUGH. Dated December 28. 6d. Relates to the use of the "lithanode" mixtures and consists in coating the leaden support electrolytically with a layer of peroxide of lead before applying any of the mixtures. 4 claims.

## 1890.

7383. "An improved battery element." J. N. LEVSEN. Dated May 12. 6d. Claim:—A new battery element, consisting of the carbon and zinc electrodes, a mixture of pulverised retort carbon and manganese, covered with a mixture of resin and pitch, all approximately in the proportions set forth, and a sack of sail cloth or other like material encompassing the whole, substantially as and for the purposes described and illustrated in the drawings.

7465. "Improvements in apparatus for telephone exchanges." J. E. KINGSBURY. (A communication from abroad by the Western Electric Company, of Chicago). Dated May 13. 8d. Relates to multiple switchboard systems of telephone exchange, and its objects are, first, to reduce the amount of wiring required between the different boards; and, second, to reduce the size of the switches, so that a larger number of lines may be brought within the reach of each operator. 12 claims.

## CORRESPONDENCE.

### Improvements in Telephone Switchboards.

I have seen the correspondence going on relative to the above subject, and as I am much interested in this important matter of switching, I should feel obliged if Mr. Kingsbury would answer the following questions, viz.:—

1. Seeing that  $14\frac{1}{2}$  feet is occupied by 1,000 subscribers, what is the greatest stretch, in feet, of the cord, presuming that the 10 boards are in one line?
2. In the event of 2,000 subscribers to the exchange at which these boards exist, in what manner would the boards be arranged?
3. What number of operators are employed to work the 10 boards, and would the number be double for 20 boards?
4. When would the exchange attain multiple rank, and in what manner would the boards and connections be arranged for such?
5. Where is the exchange at which these ten 100-line boards exist?
6. Why not give an outline of the connections, as was done in the single-cord system, and thus allow one more able to judge its merits?

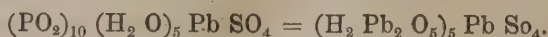
Mr. Kingsbury is evidently much in favour of his own system, and dislikes that patented by Messrs. Jackson and Sinclair; but having been shown the single-cord system by the latter gentleman, I must say *I admired the perfectness of its working*. I observe that Mr. Kingsbury has obtained protection for certain details in his system, but I fail to see, by his article of 31st October, anything very special in it, and therefore I may trouble you, ere long, with the illustration of an unpatented arrangement, proposed by myself, with a view of arriving at, or perfecting, a system worthy the brains of England's electricians.

An Electrician all his Life.

December 20th, 1890.

#### The Institution of Electrical Engineers.

Allow me to make two very necessary corrections in your report of the observations I made at the last meeting of the Institution of Electrical Engineers. The formulæ:



do not express "the chemical changes produced by electrolysis," but the composition of a certain sample of *lithanode*, which I was inclined to regard as a type of the active material in the negative element of a lead secondary battery. The former of the two expressions is the empirical, and the latter the theoretical formula. The second correction is that I have not yet obtained a discharge of 2 ampères per lb. gross weight of cell for two hours. This is what I am trying to get; but one and a-half ampères for the two hours is the most I have actually obtained.

Desmond G. FitzGerald.

[We are sorry that Mr. FitzGerald should be compelled to write to us; the report is not ours, but the authorised abstract of the discussion sent out under the auspices of the Institution. There was a time when such corrections would not have been necessary.—EDS. ELEC. REV.]

#### Underground Cables.

In your issue of the 19th inst. you publish two letters, one from Mr. Mavor and the other from Mr. Ferranti, having reference to a letter from our Liverpool agent published in the ELECTRICAL REVIEW of the 5th inst.

With regard to the cables in use at West Brompton, the statement made in the paper on Central Station Lighting was that the Fowler-Waring cables were not exclusively used by the House-to-House Company, but have been found to be the most satisfactory up to the present time. From Mr. Mavor's letter it would appear that we are incorrect in saying that these cables have been abandoned at West Brompton, and that their use has only been postponed. If this is so, still they can hardly be considered as "the most satisfactory up to the present," as our vulcanised cables are, we understand, in daily use; and Mr. Mavor admits that the difficulty to be overcome before the Fowler-Waring cables can be used is a serious one. This difficulty presumably existed at the time the paper referred to was read in January, and it appears has not yet been overcome, and the cables have not yet been in ordinary service.

With regard to the London-Deptford cables, the original statement made was, that "certainly these have been the only cables which have withstood the voltage employed by the London Electric Supply Corporation for any time; and though they subsequently developed faults, the tension (*i.e.*, 10,000 volts) was phenomenal," &c.

From Mr. Ferranti's letter it would appear that these cables are only working at 2,500 volts, and are not sufficiently insulated for the higher voltage. This does not bear out the original statement made—that these are the only cables which have withstood 10,000 volts; and although the expression, "we believe these cables have been condemned," may appear strong, in your issue of the 4th April last you refer to the "breaking

down of the Fowler-Waring cables," and in the report of the meeting of the London Electric Supply Corporation contained, in the same issue, the following occurs as an extract from the engineer's report:—"The defective mains now in use between Deptford and London will shortly be replaced by these permanent trunk mains" (*i.e.*, mains manufactured by Mr. Ferranti); and, further, in your issue of the 25th of the same month, you state "That the cables, so far, have proved to be unreliable is well known."

Surely if such statements go uncontradicted, it is a fair assumption that these cables are not reliable, and that they are to be replaced—in other words, that they are condemned.

We wish to point out that, no doubt from an oversight, several words of our agent's quotation from Mr. Ferranti were omitted from his letter, as printed in your issue of the 5th inst., and that by this omission the sense of the paragraph is entirely altered.

Wm. J. Tyler,

Secretary of the I.-R. G.-P., and T.W. Co., Ltd.

22nd December, 1890.

#### British Insulated Wire Company's Cable.

Owing to absence from Liverpool, I have just had the pleasure of reading your issue of the 12th to-day, and I notice therein a leaderette criticising the data of some tests of the above-mentioned company's manufactures.

You apply certain terms to my letter containing the figures observed, which, representing as they do your opinion, cannot be cavilled at, but how far they are merited by the MSS. you so roughly handle is questionable. The truth only having been recorded in the report referred to, it is open to anyone to cavil at the mere style of the writer, which may afford sport to any Philistine.

You state that you find "it difficult to judge of the value of the tests from insufficiency of information."

The tests were taken solely to ascertain the dielectric resistance under various conditions, electrification and capacity of electric light and telephone cables, sample lengths suitable for the purpose being used. As the tests were completed satisfactorily, mechanical data of the cables were not included. As I am aware that all your comments are intended for the public good, there is no better reply to make to your statements than to ask you to again look into the figures and impartially to weigh the results obtained which have here and elsewhere been considered most favourable. It is questionable if the substance of the letter could have been given in a few lines, as the matter included only contained such information as would be required by anyone attempting to repeat these tests. The cables were all lead-covered, but the reference made to the telephone cable maintaining its insulation in the rain had regard to the fact that the lead had been stripped off for about 12 inches at each end, and it was in this condition that the sample was left exposed, and tested after merely surface drying.

The two-yard length of electric light cable had been twisted and bent after the lead sheathing had been removed, and before immersion. In comparison with certain other cables of similar type of insulation, the test was very severe, and is conclusive evidence that the material used does not absorb moisture.

It is, of course, of the greatest interest to the electrical world to ascertain the accuracy and magnitude of tests made on cable samples, and in this light your leaderette has, I trust, elicited the information desired.

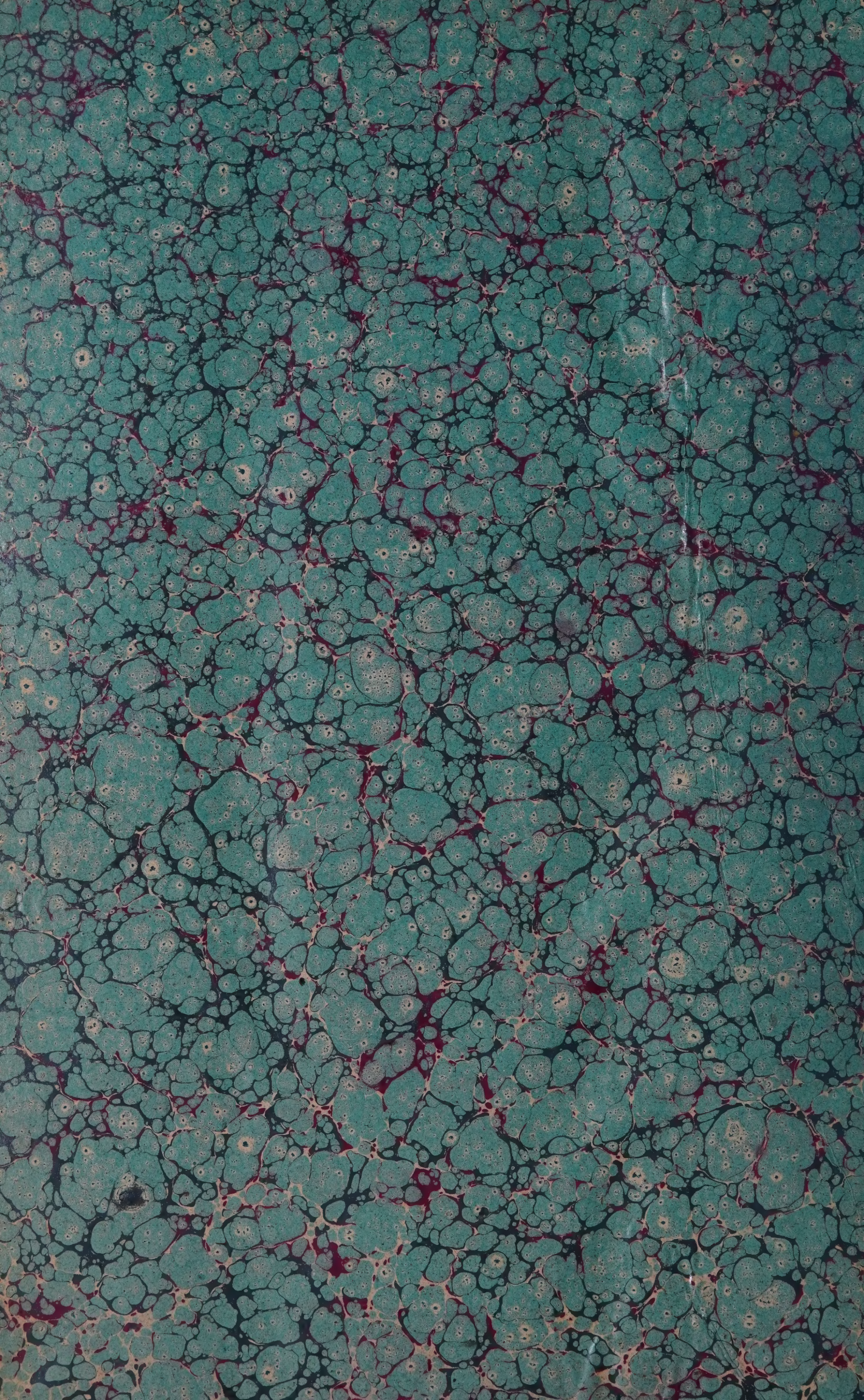
Charles H. Yeaman.

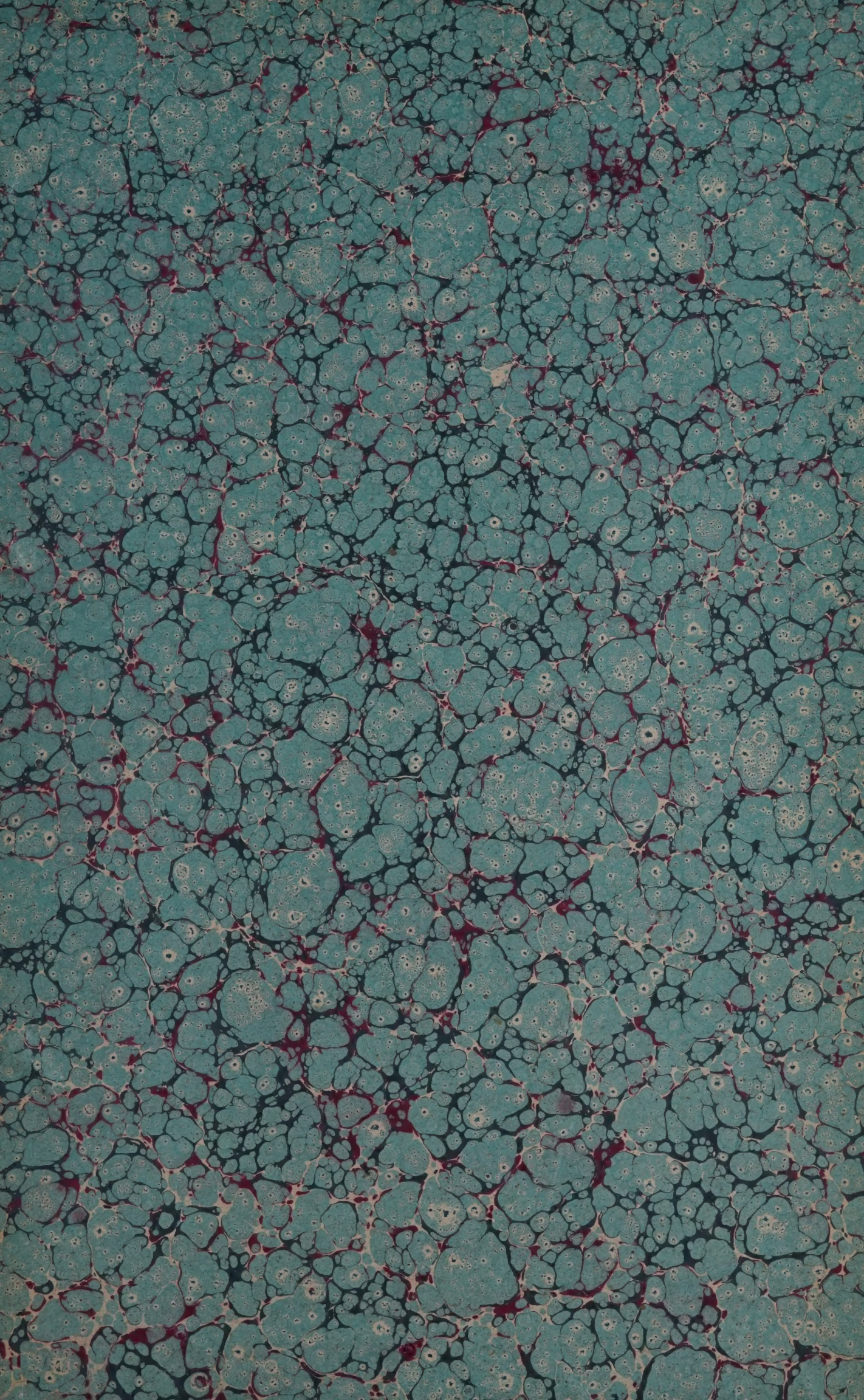
2, Albany Place, Glasgow, W.

December 20th, 1890.

[Mr. Yeaman has now given the information, of the lack of which we complained. The results of the tests (which we consider were properly made) under the conditions stated, certainly show the insulation of the cables in a very favourable light.—EDS. ELEC. REV.]







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